PROCEEDINGS

OF THE

SCIENTIFIC MEETINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

January 13, 1870.

John Gould, Esq., F.R.S., V.P., in the Chair.

The Secretary called the attention of the Meeting to certain additions to the Society's Menagerie during the months of November and December last. These were:—

1. Six Water-tortoises (*Emys*), presented by the Rev. Basil Wilberforce, November 27th. Upon being taken to the British Museum for identification, four of these animals proved to belong to a new species, which had been described by Dr. Gray at the Society's Meeting in December under the name *Emys flavipes**; and the two others to a species described by Dr. Gray at the Society's Meeting on the 11th of November as *Mauremys laniaria*†. It was unfortunate that Mr. Wilberforce was unable to state the localities of these specimens, which had been purchased from various dealers during the last ten years, some of them having been in his possession for the whole of that period.

2. A specimen of a rare American Monkey, the Ouakari (*Brachyurus ouacari*, Spix), obtained from the forests of the Rio Negro by Lewis Joel, Esq., C.M.Z.S., H.B.M. Vice-Consul at Ciudad Bolivar, Venezuela, and deposited in the Society's Gardens by Mrs. Joel, December 16th. One specimen of this Monkey had been previously living in the Society's Gardens, in 1847, an original drawing

* P. Z. S. 1869, p. 643. † P. Z. S. 1869, p. 499.

of which by Mr. Richter was now in the Society's Library*. Mr. Sclater remarked that he had little doubt that the *Simia melanocephala* of Humboldt (Rech. Zool. i. p. 316, t. xxix.) was really intended for the same animal, as it was obtained in the same locality (that is, from the Upper Rio Negro), and it was hardly likely that two so nearly allied species could coexist in the same district, the species of this group being remarkable for their distribution in definitely limited geographic areas†.

The following extract was read from a letter addressed to Mr. Sclater by Lord Lilford, F.Z.S.:—

"I notice that in the last part of the Zoological Society's 'Proceedings,' p. 276, you say that the *Otus capensis* sent to me by Major Irby last year was captured on the Rock of Gibraltar. This is a mistake; it was the *Bubo maximus* (which arrived at the Gardens at the same time with *Otus capensis*) which was caught in one of the galleries in the Rock. The *Otus capensis* was one of several which Major Irby shot near Casa Vieja, about fifty miles west of Gibraltar, beyond Tarifa. I have just received from Major Irby a very fine skin of the same species from Tangier. From what I can make out, this bird migrates northwards irregularly in autumn. Major Irby found five or six in a marsh in October 1868, and has failed to find them, or hear of them, in that locality, or elsewhere in Spain, in spring or summer. It is not a common bird near Tangier."

The Secretary read the following extracts from a letter addressed to him by Dr. A. Ernst, C.M.Z.S., dated Caracas, August 20th, 1869:—

"A few days ago one of my collectors brought me a fine male specimen of the *Echimys cristatus*, Desm. It was shot in a spot called the Palmar, which is about 4500 feet above the level of the Caribbean Sea. The animal appears to be very rare in the immediate neighbourhood of Caracas; but I was told it was pretty abundant in the hotter regions of the valley of the Tuy river. Its vulgar name is 'Catiragüa.' The colour agreed pretty well with the only description I was able to find in my books (Boitard, Le Jardin des Plantes, Mammifères, p. 345). I took the following measurements:—From tip of nose to root of tail 28 centim.; tail 22 centim.; distance between the ears 4 centim.; distance between the eyes $2\frac{1}{2}$ centim.; tip of nose to the line between the ears 5 centim.; circumference of body in its thickest part 16 centim. The animal was shot from a tree; its habits are therefore arboreal, as generally in this genus.

"Of Bats I obtained the *Vespertilio lucifugus*, Leconte. In the higher part of the river Catuche, about 6000 feet above the sea, a

* *Cf.* Dr. Gray's remarks, P. Z. S. 1849, p. 9, where there is a woodcut taken from this drawing.

† *Cf.* Wallace, P. Z. S. 1852, p. 108.

dozen of specimens were captured in a small grotto. Most of them were young animals; there was only one full-grown male amongst them. All the specimens were thickly covered by a species of *Nycteribia*; but I was unable to classify it for want of literary apparatus. My identification of the *Vespertilio* mentioned rests on the memoir on American Bats published by Allen in vol. vii. of the Smithsonian Misc. Collect. 55.

"The last steamer from Ciudad Bolivar brought, amongst other things, a few specimens of the *Fulgora laternaria*, L. My correspondent repeats in his letter the fables the Indians relate with respect to this innocent insect; but though he mentions the most marvellous things, he does not speak of any emanations of light. I think such negative evidence is worthy to be taken notice of.

"And last, but not least, I have to add a few lines with respect to a species of *Squilla* which was captured by a fisherman at La Guayra, the sea-port of this town. It is certainly a species closely allied to *Sq. mantis*; but I think it different. There are no traces of the six dorsal lines; the segments are perfectly smooth, whitish, with the exception of the anterior margin, which is of a greyish-blue colour. The posterior margin of the fifth gill-bearing articulation is minutely toothed; the following shows teeth on both edges; and this last segment has in the middle an oval protuberance of a bluish-grey colour, $1\frac{1}{4}$ inch long, and nearly $\frac{1}{2}$ inch broad. The posterior edge of the same segment has on each side three strong inwardly bent teeth, and, between these, two groups of united small teeth. The claws are armed with eight large teeth, excepting the large curved point of the claw. The carapace of the thorax has a deep and broad notch on the posterior edge, and four rather faintly impressed longitudinal lines. The underside of the animal is white; there are distinct bluish markings at the root of the spines in the claws. Length 22 centim. from the point of insertion of the eyes to the posterior edge of the last segment

"I hope these indications will be sufficient for an identification of the animal with some described species. In case it should not be so, I will try to send you our specimen over to have it duly examined and described."

Mr. Swinhoe exhibited the skin of a Mantchurian Tiger (*Felis tigris*?), measuring 7 feet 8 inches from the nose to the root of the tail, and placed alongside of it the skin of a specimen from India. He pointed out that, with the exception of the face, which had as short hair as that of the Bengal Tiger, the whole of the body of the Mantchurian beast was covered with long softish hairs, and that there was a shaggy ruff about its neck. The specimen exhibited was of a pale colour, with the stripes narrow and indistinct, especially about the shoulders and the hips. Its tail had four narrow longitudinal streaks on the upper surface for the first foot of its length, the next foot was banded irregularly, and the terminal foot regularly, with black and flavescent, ending with a broad black tip. This was the northern race of Tiger, which was tracked by the hunters among

the snows of Mantchuria and Corea. It did not wander south of Peking, but had occurred near Lake Baikal in Siberia, and, it was said, even in the neighbourhood of St. Petersburg. Mr. Swinhoe regretted that he had not yet succeeded in getting its skull. He added that on a former occasion, some years ago, he had exhibited to the Society a skin of the true Bengal Tiger, which was procured at Amoy. This southern race was found from Canton to Shanghai.

Mr. Swinhoe also showed the skin of a Leopard from the province of Kwangtung, very richly coloured and marked, but otherwise agreeing with the Leopard of India; and at the same time laid before the Meeting the skins of an adult and young of the northern Leopard, which Dr. Gray some time since (P. Z. S. 1862, p. 262, Pl. xxxiii.) had described as new (*Leopardus japonensis*), from a skin said to have come from Japan. Mr. Swinhoe remarked that this Leopard differed from the southern race also in its long shaggy hair, in the greater amount of white about it, in its bushy tail, its pale colour, and in the confused massing together of the black spots and circles. The young specimen had all the characters of the adult, except that the markings were indistinct and more in the form of spots.

Mr. Swinhoe stated that the skin before them was procured at Peking, and that the animal was found wild on the western hills near Peking, and in the country to the north (Mantchuria), extending probably to Corea and the island of Saghalien, and perhaps to Northern Japan. It seemed to him that if the northern Leopard was to be recognized as a distinct race worthy of a specific name, so also should the Tiger be. He would do his best to procure the skull of this race, as also that of the northern Leopard, and expected that the osteological characters would confirm the differences shown by the skins.

Mr. Swinhoe also produced the stuffed skin of a *Leopardus brachyurus* from Formosa, in which the tail was somewhat long, proving that this race is more akin to *L. macrocelis* than had been anticipated.

Mr. Gould exhibited, and made remarks upon, a specimen of the very remarkable new Pigeon which he had recently described under the name *Otidiphaps nobilis**, supposed to be from New Guinea.

The Rev. H. B. Tristram exhibited two skins of *Aquila nævioïdes* from India, and made the following remarks on them:—

"I have the pleasure to submit for exhibition two specimens of *Aquila nævioïdes*, recently sent to me from Etawah, N. W. Provinces of India, by my friend Mr. W. G. Brooks, C.E. Mr. Brooks had noticed a peculiarly ruddy Eagle in his neighbourhood for some months before he obtained his first specimen; and the bird not being on any Indian list, or recorded from the East, imagined he had discovered a new species. I heard from him last week that he has just obtained a third specimen near Etawah.

* Ann. Nat. Hist. ser. 4, vol. v. p. 62 (1870).


BRITISH MUSEUM

G B Sowerby lith

M & N Hanhart imp

NEW LAND & MARINE SHELLS.

"Mr. Gurney observes that the specimens now exhibited 'appear to be male and female of the true *A. nævioïdes*, identical with those found in Africa. I have never seen this larger race from India previously, or, at least, have never recognized it if I have seen it.

"'The occurrence of these two birds in India raises a curious question of nomenclature. *A. nævioïdes* is undoubtedly far more "*fulvescens*" in its average plumage than the allied smaller Indian race, which you and I have been in the habit of identifying with *Aquila fulvescens* of Gray.

"'But as it now seems that the true *A. nævioïdes* occurs in India, is it not most probable that *A. fulvescens*, Gray, is in reality a synonym of *A. nævioïdes*, and that the smaller allied but less fulvescent bird, which is peculiar to India, should be termed *Aquila vindhiana* of Franklin, without the synonym of *A. fulvescens*?'

"I also exhibit a singular specimen, received from Mr. Brooks at the same time, which Mr. Gurney considers to be a female of *A. vindhiana* of an unusually dark colour, attributable to the plumage being newly acquired after a recent moult. This bird has been considered by Mr. A. Hume to be *A. nævia*, and by others *A. hastata*."

The following papers were read:—

1. Descriptions of a New Genus, and of Eighteen New Species of Mollusks. By Henry Adams, F.L.S.

(Plate I.)

Genus Nesta, H. Ad.

Testa oblongo-ovali, superne convexa, apice terminali, subincurvo, extus decussata, sulco dorsali in fissuram desinente; apertura margine crenulato.

Nesta candida, H. Ad. (Plate I. figs. 1, 1 *a*.)

N. *testa oblongo-ovali, tenui, lirulis elevatis tenuissimis concentricis et radiantibus concinne decussata, nivea; sulco dorsali lateribus distinctis, transverse striato, fissura antica valida; apertura margine postico paulum incrassato, omnino delicate crenulata.*

Long. $5\frac{1}{2}$, lat. 3, alt. $1\frac{3}{4}$ mill.

Hab. Rea Sea (*Coll. M'Andrew*).

This pretty and delicate little form appears to be allied to *Zeidora*, A. Ad.; but the peculiar internal septum, which is a marked characteristic of that genus, is absent in *Nesta*. It may be considered a communicating link between *Zeidora* and *Emarginula*.

The genus *Zeidora* was obtained by my brother in Japan, where also he met with another singular shell, *Morchia obvoluta*, of which two specimens have been dredged by Mr. M'Andrew in the Red Sea.

Corbula sulculosa, H. Ad. (Plate I. fig. 2.)

C. *testa solida, acuminato-ovata, albida, subæquivalvi, sulcis concentricis subdistantibus ornata; umbonibus medianis, prominentibus, proximatis; latere antico ovali, latere postico acuminato; margine dorsali antice subincurvo, postice arcuato, margine ventrali vix sinuato; declivitate umbonali valde angulata.*

Long. 9, alt. 6, lat. 6 mill.

Hab. Red Sea (*Coll. M'Andrew*).

Tellina (Tellinella) virgulata, H. Ad. (Plate I. fig. 3.)

T. *testa solidiuscula, subovali, subæquilaterali, concentrice conferte lirata, liris postice rugose lamellosis, albida, radiis rubro-fuscis interruptis picta; latere antico ovali, latere postico ad extremitatem subtruncato; plica valida; margine dorsali antice leviter arcuato, postice vix recto; margine ventrali convexo, postice subsinuato; intus albida, ad marginem obscure radiata.*

Long. 25, alt. 20 mill.

Hab. Red Sea (*Coll. M'Andrew*).

Tellidora pusilla, H. Ad. (Plate I. fig. 4.)

T. *testa parva, subtriangulari, solida, concentrice lamellosa, et inter lamellas tenuissime radiatim striata; lamellis subirregularibus, subremotis, ad latus posticum serratis, pallide flava; umbonibus submedianis, acutis, compressis; margine dorsali antice subincurvato, postice subarcuato; margine ventrali convexo, postice sinuato et anguluto; flexura conspicuu; valva utraque convexa.*

Long. 10, alt. 10, lat. 4 mill.

Hab. Red Sea (*Coll. M'Andrew*).

The two other known species of this genus, viz. *T. burneti* and *T. crystallina*, are from Mazatlan and West Columbia. In the former, one valve is convex and the other slightly concave, while in *T. crystallina* and *T. pusilla* both valves are convex.

Lucinopsis (Lajonkairia) elegans, H. Ad. (Plate I. fig. 5.)

L. *testa parvula, tenui, ovato-quadrata, alba, lineis incrementi conspicuis, remotis, et striis tenuissimis confertis divaricantibus, interstitiis indentatis insculpta; umbonibus medianis, approximatis, prominentibus; lunula elongato-ovali, linea angusta circumscripta; extremitate antica ovali, extremitate postica latiore, vix convexa, cum margine dorsali angulum subarcuatum formante; margine ventrali subrecto.*

Long. 11, alt. 10, lat. 5 mill.

Hab. Red Sea (*Coll. M'Andrew*).

Semele macandreæ, H. Ad. (Plate I. fig. 6.)

S. *testa oblongo-ovali, inæquilaterali, solidula, albida, lamellis erectis tenuibus concentricis ornata, interstitiis minutissime radiatim striatis; umbonibus prominentibus, postmediunis, contiguis; margine dorsali postice subrecto, antice incurvato, margine ven-*

trali arcuato; extremitate posteriore subovali, cum margine dorsali angulum formante, extremitate anteriore rotundata; valvis ad marginem ventralem compressis, postice flexuosis et angulo dorsali curvato instructis.

Long. 23, alt. 18, lat. 9 mill.
Hab. Red Sea (*Coll. M'Andrew*).

CHIONE PULCHELLA, H. Ad. (Plate I. fig. 7.)

C. *testa transversim ovali, solidula, convexa, æquilaterali, lamellis concentricis erectis ornata, ad extremitatem posticam validis et granulosis, inter lamellas radiatim striatis, carnea, rubro marmorata; umbonibus medianis; lunula angusta, bene impressa; intus rubra.*

Long. 10, alt. $5\frac{1}{2}$, lat. $3\frac{1}{2}$ mill.
Hab. Red Sea (*Coll. M'Andrew*).

LORIPES DECUSSATA, H. Ad. (Plate I. fig. 8.)

L. *testa subglobosa, solidula, striis tenuibus, elevatis, confertis, concentricis et radiantibus decussata, alba; umbonibus submedianis, elevatis, acutis, approximatis, antrorsum versis; margine interno concinne crenulato.*

Long. 9, alt. 11, lat. 9 mill.
Hab. Red Sea (*Coll. M'Andrew*).

PERNA FULGIDA, H. Ad. (Plate I. fig. 9.)

P. *testa transversa, elongato-ovata, tumida, castanea, nitida, area mediana pallidiore; umbonibus subterminalibus, contiguis, violaceis; margine dorsali in medio obtuse angulato, margine ventrali antice convexo, postice parum incurvato; superficie valvarum sulco levi radiatim bipartita.*

Long. 28, alt. 15, lat. 11 mill.
Hab. Red Sea (*Coll. M'Andrew*).

LIMOPSIS CONCINNA, H. Ad. (Plate I. fig. 10.)

L. *testa solidula, subovali, subæquilaterali, concentrice irregulariter lirata, radiatim confertissime tenuissime striata, alba; umbonibus submedianis, prominentibus, incurvatis; latere antico rotundato, latere postico longiore, ad extremitatem subangulato; denticulis cardinalibus utrinque ad 5; margine intus crenato-sulcato.*

Long. 4, alt. 4, lat. $2\frac{3}{4}$ mill.
Hab. Canary Islands (*Coll. M'Andrew*).

LIMÆA PECTINATA, H. Ad. (Plate I. fig. 11.)

L. *testa solidula, triangulari-ovata, subæquilaterali, subauriculata, alba, costis radiantibus ad 19, rotundatis, elevatis, imbricatis ornata, interstitiis concentrice laminatis; margine crenato; umbonibus prominulis; area ligamenti vix excavata; margine cardinali vix obliquo, recto, denticulis ad 11 utrinque instructo.*

Long. $2\frac{1}{2}$, alt. 3, lat. 2 mill.
Hab. Red Sea (*Coll. M'Andrew*).

Melanoides swinhoei, H. Ad. (Plate I. fig. 12.)

M. *testa elongato-turrita, tenuiuscula, spiraliter costata, costis ad basim evanidis, sursum longitudinaliter plicata, epidermide nigro-fusca induta, decollata; anfr. ad* 10 *superstitibus, subplanatis, infra suturam excavatis; apertura acuminato-ovali, antice producta, callo columellari mediocri, intus cærulescente.*

Diam. 14, alt. 43 mill.

Hab. Hainan (*Mr. Swinhoe*).

Bithynia robusta, H. Ad. (Plate I. fig. 13.)

B. *testa late profundeque rimata, ovato-conica, solidula, oblique irregulariter striata et sublente transversim levissime striatula, olivacea, truncata; anfr. superstitibus ad* 4, *convexiusculis; apertura subovali, postice angulata, antice subcanaliculata; perist. continuo, recto, margine dextro intus subcalloso, columellari incrassato.*

Diam. 8, alt. 13 mill.

Hab. Hainan (*Mr. Swinhoe*).

Rumina (Subulina) teres, H. Ad. (Plate I. fig. 14.)

R. *testa turrita, tenuiuscula, oblique minutim striata, pallide fulva; spira elongata, apice obtuso, sutura subcanaliculata; anfr.* 9, *convexiusculis, ultimo basi attenuato,* $\frac{1}{3}$ *longitudinis paulo superante; columella arcuata, basin aperturæ non attingente, subtruncata; apertura subovali; perist. simplici, acuto, margine dextro sinuato.*

Long. 25, diam. 6 mill. Ap. 7 mill. longa, $3\frac{1}{2}$ lata.

Hab. Hainan (*Mr. Swinhoe*).

Helix (Camœna) hainanensis, H. Ad. (Plate I. fig. 15.)

H. *testa imperforata, globoso-turbinata, solidula, irregulariter rugosa et cicatricosa, flava, fasciis variis rufo-castaneis ornata; spira turbinata, apice obtuso; anfr.* 6, *convexiusculis, ultimo non descendente; apertura lunato-ovali; columella subverticali, brevi, dilatata; perist. expanso, reflexiusculo, marginibus callo tenui junctis.*

Diam. maj. 40, min. 37, alt. 40 mill.

Hab. Hainan (*Mr. Swinhoe*).

Pterocyclos hainanensis, H. Ad. (Plate I. fig. 16.)

P. *testa depressa, late umbilicata, tenuiuscula, leviter striata, fulvo-lutea, epidermide cornea, laminis distantibus dispositis induta; spira paulum elevuta, apice prominulo; anfr.* 5, *rotundatis, ultimo non descendente; apertura obliqua, circulari; perist. duplicato, interno superne breviter inciso, externo expanso, supra sinum latiusculo, subcucullato. Op. arctispirum, extus concaviusculum, marginibus anfractuum laciniatis.*

Diam. maj. 15, min. 12, alt. 10 mill.

Hab. Hainan (*Mr. Swinhoe*).

BULIMULUS DAMARENSIS, H. Ad. (Plate I. fig. 17.)

B. *testa vix rimata, oblonga, solida, longitudinaliter plicoso-striata, plicis obtusis, subarcuatis, albida, interdum strigis corneo-fuscis ornata; spira superne attenuata, apice obtuso, corneo; anfr.* $10\frac{1}{2}$, *convexiusculis, ultimo* $\frac{1}{3}$ *longitudinis æquante; apertura subovali, basi angulata; perist. recto, calloso, marginibus callo junctis, columellari dilatato, appresso.*

Long. 24, lat. 9 mill.

Hab. Damara Land (*Coll. H. Ad.*).

This species is allied to *B. tauricus*, Lang., but differs from it in being less rimate, and in the spire being attenuated at the upper part.

BULIMULUS PYGMÆUS, H. Ad. (Plate I. fig. 18.)

B. *testa rimato-perforata, ovata, solida, alba, striis longitudinalibus et spiralibus minutissimis obsolete decussata; spira brevi, convexo-conica, apice obtuso, sutura impressa; anfr.* 6, *convexis, ultimo* $\frac{1}{2}$ *longitudinis æquante; columella subverticali; apertura ovali; perist. recto, crasso, margine columellari arcuato, dilatato, reflexo, perforationem subtegente.*

Long. 13, diam. 8 mill.

Hab. Damara Land (*Coll. H. Ad.*).

DESCRIPTION OF PLATE I.

Figs. 1, 1*a*. *Nesta candida*, p. 5.
2. *Corbula sulculosa*, p. 6.
3. *Tellina* (*Tellinella*) *virgulata*, p. 6.
4. *Tellidora pusilla*, p. 6.
5. *Lucinopsis* (*Lajonkairia*) *elegans*, p. 6.
6. *Semele macandreæ*, p. 6.
7. *Chione pulchella*, p. 7.
8. *Loripes decussata*, p. 7.
9. *Perna fulgida*, p. 7.
Fig. 10. *Limopsis concinna*, p. 7.
11. *Limæa pectinata*, p. 7.
12. *Melanoides swinhoei*, p. 8.
13. *Bithynia robusta*, p. 8.
14. *Rumina* (*Subulina*) *teres*, p. 8.
15. *Helix* (*Camæna*) *hainanensis*, p. 8.
16. *Pterocyclos hainanensis*, p. 8.
17. *Bulimulus damarensis*, p. 9.
18. —— *pygmæus*, p. 9.

2. Description of a new Generic Type of Entozoon from the Aard Wolf (*Proteles*); with Remarks on its Affinities, especially in reference to the question of Parthenogensis. By T. S. COBBOLD, M.D., F.R.S., F.L.S.

On the 4th of November last I received from Professor Flower, F.R.S., a small bottle containing some Nematode worms, accompanied by a letter stating that the parasites had been "found loose in the peritoneal cavity of *Proteles cristatus*." The mere circumstance that the carnivorous "host" had never before been properly anatomized, naturally led Mr. Flower to suppose that the worms would prove new to science; and this inference could hardly fail to be strengthened by the rather uncommon fact of the occurrence of

round worms in large numbers in the general serous cavity of the abdomen. Moreover there had to be taken into consideration the peculiarities of the digitigrade mammal thus infested, its comparative rarity, and also its limited area of geographical distribution, these several influences being unquestionably concerned in the "fixation," so to speak, of the specific form likely to be encountered. It is not surprising therefore that our anticipations in the above relation should have been more or less completely verified; and accordingly it turns out that we here encounter a new genus of internal parasites offering peculiarities of structure, and apparently also of habit, which on the whole suggest a slight approximation to the ordinary filarine genera, on the one hand, but with a closer connexion with the remarkable genus *Dracunculus* on the other. When all the facts bearing upon the genetic relations of the Guinea-worm come to be fully known, it may then turn out that my determinations, in respect of the affinities of the new worm, are somewhat wide of the mark; but, in the meantime, the following data will show the grounds on which I have provisionally asserted this alliance. All the specimens received by me, thirty-four in number, were females; therefore, in the absence of any knowledge of the corresponding male parasites, the following characters must be regarded as applicable only to one of the sexes:—

Order NEMATODA, Rud.

Suborder Nem. Proctucha, Dies.

Family Filaridea, Dies.

Subfamily Cheilonemidia, Dies.

Acanthocheilonema, g. n.

Head furnished with three spinous lips; body filiform; female endoparasitic in mammals.

A. dracunculoides, sp. n.

Body smooth, finely attenuated in front, uniformly thick below; head sharply pointed when the lips are closed, obtuse when exserted; neck spirally twisted in four or five circles; tail abruptly truncate, with a solitary, central, very slightly projecting lobe; no reproductive orifice visible.

Length $1\frac{1}{4}''$ to $2\frac{1}{2}''$; general breadth $\frac{1}{90}''$ to $\frac{1}{80}''$.

This combined generic and specific description, though sufficient for future identifications, may, I think, be profitably supplemented by other particulars relating to size, external form, and general organization, amongst which I have remarked the following:—The head immediately beneath the insertion of the lips measures so little as the $\frac{1}{1000}''$ in diameter, whilst the neck proper gives only twice the same amount of thickness. The tail is fully $\frac{1}{90}''$ in breadth, its feebly pronounced central lobe being no more than the $\frac{1}{260}''$ wide at the base. The mature eggs, or those containing more or less per-

fected embryos, present an average length of $\frac{1}{750}''$ by $\frac{1}{830}''$ in width; but the fully developed embryos, when set free and unrolled, give an average measurement of $\frac{1}{115}''$ from head to tail. The larvæ, however, are remarkably thin, the longest of them not exceeding the $\frac{1}{3000}''$ in thickness; yet, notwithstanding their smallness, they have already attained the general form of their parents, the finely pointed anterior extremity of the body scarcely exceeding the $\frac{1}{10,000}''$ in diameter. In this connexion, I must also not omit to mention that on removing the batch of parent worms from the phial in which they were sent, I observed several of them to be adhering to one another, the various points of union being marked by the presence of minute particles of débris. To the naked eye these particles presented a pale yellow colour, their irregular outline and general aspect suggesting that they were only patches of mucus, connective tissue, or something of that sort derived from the "host" during dissection. However, to my astonishment, on microscopically examining one of these little masses, measuring about the $\frac{1}{20}''$ in length, I found it to consist of thousands of embryos agglutinated together. So consolidated had they become by the action of the spirit in which they were preserved, that I had the greatest difficulty in isolating any one of them; and since, also, they were, individually, much shrivelled and twisted, their measurements could not be very accurately taken. Making all due allowance for contractions and alterations of shape, I did not find that their separate total lengths perceptibly exceeded that of the embryos obtained from the interior of the parent worms. In the mass they were coiled upon themselves and each other in inextricable confusion. I purposely dwell upon these apparently trivial matters because it seems to me of the highest importance to ascertain whether the escaped embryos were, or were not, caught in the act of migrating. They may have accumulated only as the result of accidental evacuation from specimens of the parent worms injured during the dissection of the "host;" in this case, however, though the egg-envelopes would naturally have disappeared, I should probably have noticed some of the freed embryos in a less perfectly developed condition than that in which all of them actually appeared to be. Those who are acquainted with the migratory habits of the Nematode Entozoa will readily conclude that these embryos were, at the time of the "host's" death, accomplishing what, in other cases, has been appropriately termed a "first active wandering" on their own account; and probably a passive transference to some unknown intermediary bearer would, had they lived, have been essential to the further development of these particular larvæ. Be that as it may, in the matter of ascertaining their mode of actual escape (supposing them to have obtained their freedom naturally) there yet remains the rather awkward circumstance that I have not yet succeeded in procuring evidence of the existence of any reproductive outlet in the body of the parent worm.

In establishing a new genus for the reception of this interesting form of Entozoon, some explanation is certainly necessary. At once, therefore, I may remark that I should have preferred to designate

the genus as *Tricheilonema*; and, indeed, I had already so written it, when I afterward found that the late C. M. Diesing had already employed the same generic title for a parasite of a somewhat different type. In his final revision of the Nematoda, communicated to the Vienna Academy in 1860, he places this Nematode (described in his 'Systema Helminthum' as a species of *Filaria*) as the type of his new genus *Tricheilonema*; whilst, unfortunately, in the Introduction or Conspectus of the same revision, this genus, *Tricheilonema*, appears under the synonym of *Schizocheilonema*. This complication of terms is vexatious—the more so since his term *Tricheilonema* would have been much more suitable for the designation of our new parasite than for the particular form of *Filaria* there described as having been obtained from the œsophagus of an Austrian Snake. On the other hand, since Diesing's ready method makes no pretentions towards a natural classification of the Entozoa, and since, also, in the present state of our knowledge, it is much more convenient to utilize his system of arrangement than those of other systematists, there is the less reason to regret the necessary introduction of a new generic term. If Schneider's system be more natural, it is, at all events, much less complete. Without further apology, therefore, on this score, I may also remark upon the great difficulties surrounding a natural classification of the parasitic Nematodes. The variety of characters they display, especially at different stages of their growth, the remarkable disparity of size occasionally shown by the sexes, to say nothing of the still more astonishing fact that the adult female Entozoon may itself occur in two totally distinct forms—all these peculiarities, not to mention many others (associated with or depending upon their migratory habits), add to the difficulties of taxonomy. These instances of dimorphism, it is true, are now no longer believed to be confined to the Nematode Entozoa, certain Entomostraca, Aphides, and Bees; nevertheless the recent additions on this head are mainly a confirmation of the remarkable discoveries of Leuckart and Mecznikow in respect of the life-phases and development of *Ascaris nigrovenosa*. In this connexion one may particularize the observations of Prof. Leuckart respecting sexual dimorphism as it occurs in *Coccus* and in *Chermes*, of Prof. Häckel, who finds the naked-eyed *Geryoniadæ* capable of producing (from the walls of the stomach) medusoids totally unlike their parents, and of Prof. Claus in respect of the Nematode *Leptodera appendiculata*. It was reserved, however, for Prof. Claparède to discover proofs of the existence of similar phenomena amongst the Annelids properly so called. By a recently published brochure (which the author has kindly sent me), I gather that the occurrence of two distinct sexual forms presented by *Nereis dumerilii* does something more than confirm the statements of the above-named authorities, since the dimorphic phases of this singular Annelid have something about them altogether peculiar, if not unique*. The sexually mature *Nereis*, we are told, loses for a time its sexuality, increases in size

* Recherches sur des Annélides (p. 38). Tiré des Arch. des Sci. de la Bibl. Univ. Oct. 1869.

and segmentation, then becomes sexual again, and ultimately has the power of transforming itself into a *Heteronereis*. This would signify little, perhaps, if the two phases were only slightly different in character; but it must be borne in mind that they represent type forms of genera hitherto regarded as utterly disconnected and entirely distinct. If Prof. Claparède's observations and conclusions should be verified and extended by further researches, we shall have fallen upon another page of fruitful discovery bearing upon the so-called law of "alternate generation." In touching upon these genetic phenomena, my object is to bring about a probable explanation in connexion with the development of the parasitic species now before us. From the first, my suspicions were roused by peculiarities of structure observable in *Acanthocheilonema* which forcibly reminded me of *Dracunculus*. Knowing as we do, to some extent, the sexual characteristics of this aberrant parasite, and keeping in view, at the same time, Prof. Schneider's interpretation of cognate facts displayed by the singular genus *Sphærularia*, it occurred to me that the characters exhibited by *Acanthocheilonema* afforded indications of a new and important link in the complex chain of Nematode affinities. Thus all the specimens I have examined are females; the oral, anal, and reproductive apertures are either entirely obliterated, or, from their closure and excessive minuteness, have escaped observation; whilst the whole parasite may be summarily described as an elongated sac, crammed from end to end with embryos in all stages of development. It should not be forgotten that, for a long time, the mouth and even the intestinal tract of *Dracunculus* escaped detection, and at the present hour (notwithstanding Bastian's remarkable discoveries in this relation) the existence of an anal outlet has not been actually demonstrated. The alimentary canal of *Acanthocheilonema* is visible throughout the greater part of its course, but not in the immediate vicinity of the head. One noticeable difference between the two genera consists in the fact that whereas in *Dracunculus* the embryos lie free in all stages of growth in the uterine cavity, in *Acanthocheilonema* they are still surrounded by a chorional envelope. Our new species is therefore an ovoviviparous Entozoon belonging, like *Dracunculus*, to that category of Nematodes which are parasitic only during the propagative state. It is, I believe, maintained by Schneider in the case of *Sphærularia* (his views, however, being opposed to those given by Sir John Lubbock in his admirable memoir on this genus), and by Bastian in the case of *Dracunculus*, that the mode of propagation in these worms is entirely asexual, this opinion having received the general support of Prof. Huxley. For my own part I wish to say that when, in 1864, with a full knowledge of the facts brought forward as regards the Guinea-worm, I offered a contrary interpretation of the phenomena, I did so from no other motive than that of honest conviction; and even now I hold that an exclusively agamogenetic mode of propagation for these worms cannot be successfully maintained. Keeping before us those recent and important additions to our knowledge to which I have here called attention, I am of opinion that *Dracunculus*, in the form commonly known, will

turn out to be but one of two phases of the same female, the parasitic, in contradistinction to the non-parasitic, form, having the power of reproducing agamogenetically. Probably it will eventually appear that other worms known to us only in the female condition are forms of this character. Provisionally I place *Sphærularia* and *Acanthocheilonema* in this category; and should my conception of their parthenogenetic relations be ultimately proven correct, we shall have arrived at the solution of many difficult problems which have been put forward by writers and investigators. For example, as regards the Guinea-worms, Prof. Bastian very naturally asks, "Why are females only discovered in the human body?" and again, "Is there one species of *Dracunculus* only, or are there many, corresponding with different species of microscopic Filaridæ?" If my interpretation of the facts be correct, these and suchlike questions are at once satisfactorily answered. If, as Carter supposes, *Urolabes palustris* be the progenitor of *Dracunculus medinensis*, there can be no impropriety in asserting a similar genetic relation for many allied forms. Not merely may we look to such antecedents in favour of the species already mentioned, but I have little hesitation in claiming a corresponding origin for the so-called "Loa" (*Dracunculus loa*, T. S. C.), which infests the eyes of Negroes of the Angola coast—and for the *Filaria* (*Dracunculus æthiopicus*, Dies.) of Valenciennes, found in the cellular tissue of the extremities and abdomen of a Carnivore from Cordofan (*Felis guttata*). Both of the above are known to science only in the female state; and the same may be said of many other filarine species whose origin, migratory habits, and final destinations necessarily remain, in the present state of our knowledge, a mere matter of conjecture. In conclusion, therefore, let me repeat that I regard *Acanthocheilonema* as a parthenogenetic female whose embryos probably gain access to the outer world by first entering the intestinal canal of the "host," ultimately passing out by the natural passages. In the free state, like *Rhabditis*, they probably give rise to a new progeny by the ordinary sexual process, all or part of this progeny becoming parasitic and parthenogenetic females.

3. Brief History of the Introduction of Salmon (*Salmo salar*) and other *Salmonidæ* to the Waters of Tasmania. By Morton Allport, F.Z.S., F.L.S.

In the year 1841 the late Mr. Frederick Chalmers, of Brighton in Tasmania, who was then Master of a vessel trading from London, applied to Dr. Mackenzie, of Kinellan, by Dingwall, Ross-shire, Scotland, with a view to obtaining Salmon-fry for transport to Tasmania. The fry were not obtained in time for the departure of the vessel, as appears by letters published in the 'Proceedings' of the Royal Society of Tasmania (vol. i. p. 281); and this abortive attempt would scarcely be worth recording but for the curious fact that even

then Dr. Mackenzie suggested the sending impregnated roe as more likely to lead to success than any attempt to carry the living fish. The Doctor's description of his method of impregnating the roe from fresh-killed fish by rubbing it and the milt together would, however, astonish a modern pisciculturist as much as his notion that the impregnated spawn placed in a basket of gravel and hung in the ship's tank could possibly live many days in tropical weather.

In the year 1848 a gentleman belonging to the Tasmanian Survey Department, Mr. James Ludovick Burnett (then on leave of absence in England), visited Mr. Young, of Inverness-shire, manager of the Duke of Sutherland's Salmon-fisheries, and consulted him on the practicability of introducing Salmon and Trout into Tasmania. Mr. Young suggested two methods for trial—one, to bring out the spawn; and the other, to bring young fish. On the whole, Mr. Young gave the preference to the latter method, which is the more remarkable as from the account of one of his experiments it is clear that he had accidentally been upon the verge of discovering the very method which, after many years, led to success. In the experiment alluded to, Mr. Young caused the fecundated ova, packed in baskets of gravel, to be hung in a running stream at different distances from the shore. During a severe frost one or two of the baskets nearest the bank, and which were in comparatively still water, were frozen hard on the surface, and Mr. Young supposed that the vitality of the eggs was destroyed; but he let them remain, and discovered that the only effect of the reduced temperature was to delay the hatching of the ova for several days.

On August 13, 1849, Sir William Denison, then Lieutenant-Governor of Tasmania, wrote to Earl Grey on the subject of the introduction of Salmon, and in his letter mentioned that several attempts had been made to bring out the spawn, but they had all failed. Unfortunately no official record seems to have been kept of such attempts; but they were probably made in some of the vessels employed in the convict-service, and entrusted to men who took little or no interest in the experiment. A long correspondence afterwards took place on the subject, which was wound up on May 16, 1850, by a letter from Earl Grey declining to take any further steps in the matter on the ground that the project of fitting up a welled smack to carry out the living fish, as finally suggested by Mr. Young, would involve too great an expense.

Mr. Burnett and Sir William Denison still firmly believed that Salmon were to be brought out; and that belief culminated in the first attempt, of which any detailed record can be found, to transport Salmon-ova to Tasmania. The Home Government employed Mr. Gottlieb Boccius, under whose superintendence a large oval tub was constructed of wood cased in lead, capable of containing sixty gallons of water besides the requisite quantity of gravel; and on the 31st of January, 1852, this tub, containing 50,000 ova of Salmon and Trout, was shipped on board the 'Columbus' at London, and slung below and on one side of the fore hatchway.

Mr. Boccius, who himself procured the ova, gave minute directions

as to the change of the water at fixed intervals, and warned the captain of the vessel that he might expect the Trout-ova to hatch about the 15th and the Salmon-ova about the 20th of April. On the 1st of March, however, in latitude 14° 30′ north and longitude 26° west, the ova of both began to hatch, and continued to do so for about a fortnight, after which time the water became thick and putrid, the weather being intensely hot. As the ship approached colder latitudes, the water gradually cleared, but no symptoms of life appeared in the tub; and when the vessel arrived in Tasmania, Dr. Milligan, then Secretary of the Royal Society of Tasmania, and Mr. J. L. Burnett carefully examined, first the water in the tub, and then the gravel, but without finding any traces of either spawn or fish.

Mr. Burnett, in an admirably written account of this experiment, published in the 'Proceedings' of the Royal Society of Tasmania' (vol. ii. p. 288), suggested that in future the temperature of the water in which the ova are placed should, if practicable, be regulated by means of ice.

From a letter from the Duke of Newcastle to Sir William Denison, dated the 2nd of June, 1853, enclosing a voluminous report from Dr. Boccius on the causes of failure, it appears that the cost of the experiment in the 'Columbus' was £300, which was charged to the land-fund of the colony.

On the 12th of June, 1852, J. C. Bidwell, Esq., Commissioner of Crown Lands in New South Wales, forwarded to His Excellency Sir William Denison a paper entitled "Notes on the Establishment of Salmon and other Fish in the Rivers of Tasmania and New Zealand," which paper was published in the 'Proceedings of the Royal Society of Tasmania' (vol. ii. p. 326). The following extract will show that Mr. Bidwell was the first person who recommended the exact process by which success was ultimately attained more than ten years afterwards, though several have claimed the merit of the discovery at a later date. "On mentioning the subject of the introduction of fish from foreign countries to the late Earl of Derby, he informed me that he had been extremely unsuccessful in his attempts to breed exotic fish in England; and I do not think that there is an instance of any fish not belonging to the Cyprinidæ having been successfully established as colonists in any country; but I believe the want of success may have arisen almost entirely from the small number of individuals, which, if imported alive, it would be at any time possible to turn loose, and that if thousands could be liberated at once, the chances would be in favour of any predaceous fish establishing itself in a new river in any suitable climate. Now to do this it would be necessary to bring and hatch the spawn. *And I think that by packing spawn in ice there would be no difficulty in preserving its vitality for a much longer time than would be required. It is not probable that the vitality of fish-spawn would be destroyed even by freezing; but by merely packing it in ice there would be no danger of actual freezing, as the ice would always be in a melting state.*"

Thus the whole difficulty was foreseen and provided against; and

it seems marvellous now that Mr. Bidwell's suggestion was not earlier acted upon; but after the paper was read, it was little likely to attract attention, as it was indexed in the volume referred to under the letter B simply as a letter from J. C. Bidwell on the introduction of fish, and was only recently brought to light in the close search for every scrap of information relating to the early history of the Salmon experiment.

Early in the year 1858 the Royal Society of Tasmania appointed a committee of the Fellows to consider certain questions submitted by the then Colonial Secretary relative to the introduction of Salmon into Tasmania and the payment of a reward of £500 voted by the Tasmanian Parliament for such introduction. The report of this committee, dated the 16th of March, 1858, amongst other things, strongly urged on the Government the necessity of providing breeding-ponds for the deposition of ova or fry on their first arrival in the Colony; and on this suggestion the Government afterwards acted.

In the year 1859 Mr. James Arundel Youl, a gentleman who from that date expressed his conviction of ultimate success, and has exhibited untiring zeal and industry in the management of such portions of the various attempts as had to be conducted in Great Britain, prevailed upon a body of gentlemen in England, known as the Australian Association, to take up the cause; and ultimately they despatched about 50,000 Salmon-ova in the ship 'S. Curling' from Liverpool, bound to Melbourne, under the charge of one Alexander Black.

The 'S. Curling' sailed on the 25th of February, 1860, having fifteen tons of Wenham-Lake ice in an ice-house on board to keep down the temperature of the water supplied to the apparatus in which the ova were placed; but on the 24th of April, and the fifty-ninth day out, the last of the ice melted and the last ovum died, no practical knowledge whatever having been derived from the experiment. By some accident no intimation of the intention to despatch ova by the ship 'S. Curling' reached Tasmania till after the departure of the vessel from England; but upon the intelligence being received, and to prevent the loss of any ova which might have arrived, the Government caused suitable ponds to be rapidly constructed on the banks of a small stream known as the "North-west Bay River," about twelve miles from Hobart Town. These ponds were ultimately abandoned in favour of a more suitable site.

In the year 1860 the question of the introduction of Salmon was referred to a joint committee of both Houses of the Tasmanian Legislature; and, acting upon a suggestion of that committee, the Government afterwards appointed a body of Honorary Commissioners to whose management the whole experiment was thenceforth intrusted.

The next attempt was made in 1862, in the 'Beautiful Star,' a small iron vessel of 120 tons burden, built for a steamer, but sent out under canvas.

An ice-house was built between decks, and very elaborate apparatus of two kinds prepared for the reception of the ova, 50,000 in number. In the ice-house a deal box containing ova packed in wet

moss was imbedded, at the suggestion of Mr. C. H. Moscrop, Manager of the Wenham-Lake Ice Company, London, as appears by a letter from that gentleman published in the 'Times' of the 13th of July, 1863. The management during the voyage was intrusted to Mr. William Ramsbottom, who had been engaged in Melbourne and sent to England for the purpose. On the 4th of March, 1862, the 'Beautiful Star' left London, and on the 8th was compelled, through stress of weather, to put back to the Downs; in this short period from 6000 to 7000 of the ova died. On the 13th of March the 'Beautiful Star' left the Downs; and on the 16th the filler-in of the screw propeller was carried away, which compelled her to put back to Scilly for repairs. The vessel left Scilly on the 24th of March, and encountered a furious gale in the Bay of Biscay on the 27th, during which time the ova were destroyed in vast numbers. Fine weather succeeded the gale; but it was manifest, from the delays already experienced and the bad sailing-qualities of the vessel, that the ice could not hold out even to get through the tropics. At the end of April and beginning of May the temperature of the water began to rise, and many of the ova died on the point of hatching, a large number with the head of the fish protruding. On the 8th of May Mr. Ramsbottom, much against his will, was compelled to enter the ice-house to procure blocks of ice, which he placed in the deck-tank, thus reducing the temperature of the water. After using a considerable portion of ice, Mr. Ramsbottom came upon the deal box which had been placed in the ice-house, the lid being broken by the rolling about amongst the ice. Lifting out some of the moss, Mr. Ramsbottom thought the ova looked healthy, and procured a vessel of clean water and placed ova and moss together in it. To his utter astonishment he found nineteen living and healthy ova, which he carefully transferred to the trays in the suspended apparatus.

On the 17th of May the ice was finished; on the same day the temperature of the water rose to 65°, and the last of the ova died, seventy-four days from the commencement of the voyage, and eighty-eight days from the taking of the spawn from the fish. Towards the end of April from three to six of the ova were hatched per day; and thirty of those hatched appeared in perfect health; one lived ten days. The ova taken from the deal box lived nine hours longer than any of the others, and withstood a higher temperature.

Taking into consideration the pertinacity with which a portion of the ova retained life for seventy-four days in spite of the disastrous circumstances to which they were subjected during this voyage, the Tasmanian Salmon Commissioners felt certain that the ova could be introduced, and made a strong appeal to the Government of the Colony to repeat the experiment. Upon receiving Mr. Ramsbottom's report, they decided upon sending him to England expressly to try the experiment of packing ova in ice with a view of retarding their development; and this experiment was accordingly tried in London under the direction of Mr. Youl during the winter of 1862 and 1863.

The wonderful success of that trial, showing that ova may be

hatched safely after being buried in ice 150 days, has been fully published to the world; but why this was likely to prove successful has not perhaps been publicly explained. Even Mr. Frank Buckland, in his book on fish-hatching, speaks of freezing the ova, and thereby greatly misleads his readers. It was long ago shown that actually to freeze ova was to kill them in a few days, or, at most, weeks. The question then was, how could they be kept at an equable temperature just above the freezing-point? If a block of ice (the sensible temperature of which is 32° Fahrenheit) be immersed in water of a higher temperature, a portion of the ice will melt until the heat of the water falls to 32° F., but no more of the ice will be afterwards melted until the temperature of the water is again raised. If the ice could cool the water below 32°, a portion of the water would be frozen; but to effect this, a further portion of the ice must be melted, and water at 32° is not capable of melting ice. If vessels containing creams be immersed in ice for a month, no change takes place in their contents; but convert a portion of the surrounding ice to water by the admixture of any deliquescent salt, and the submerged creams are instantly frozen. Therefore by this beautiful provision of nature any substance above the freezing-point buried in ice can never fall to the freezing-point till the ice next to it is converted to water; and so long as any ice remains, the buried substance will continue at a low temperature certainly, but above the freezing-point; and to this principle success was due.

After many interviews with the owners of various ships, Mr. Youl (to whom Tasmania is greatly indebted for his determined perseverance in this respect) received the munificent offer from Messrs. Money, Wigram, and Co. of 50 tons of room gratis in their clipper-ship 'Norfolk,' bound to Melbourne. An ice-house capable of holding 30 tons was built in a situation admirably chosen for the purpose—on the lowest deck, amidships, and equidistant from stem and stern, in the position in which the motion of the vessel would be least felt. With much difficulty, and at the cost of great personal exertion on the part of all concerned, about 90,000 ova of the Salmon (*Salmo salar*) and about 1500 ova of the Trout (*Salmo fario*) were obtained and safely packed in deal boxes, each a foot long, 8 inches wide, and 4 inches deep. In some of the boxes a layer of charcoal was first placed on the bottom, then a layer of moss damped in pure water; then ova were lightly placed on the moss, and the whole covered with another layer of damp moss, upon which the lid was screwed down. In the remaining boxes the charcoal was omitted, the packing otherwise being the same. Through the lid and bottom of each box several small holes were drilled; and all the ova were packed in 181 boxes. The boxes were next placed on the bottom of the ice-house, which was filled up with Wenham-Lake ice, and the whole securely closed. All being complete, the vessel sailed from London towards the end of January 1864, and left Falmouth on the 28th of that month. On the 15th of April the 'Norfolk' arrived in Melbourne. On the next day the ice-house was opened and the small boxes unpacked. The lid of one box was then re-

moved by Mr. Ramsbottom with fear and trembling; but, to his great satisfaction, a large number of the imbedded ova were found to be alive. Eleven of the small boxes were then left in Melbourne; and the remaining 170 were placed on board Her Majesty's colonial steam-ship 'Victoria,' in large open packing-cases with holes drilled in the bottoms. Broken ice was placed on the tops of the small boxes in each packing-case, larger ice was piled on the cases, and the whole were then covered with bags of sawdust and blankets; about half the ice had melted during the voyage. On the 17th of April the 'Victoria' left Melbourne, and arrived at Hobart Town on the 20th. The packing-cases and ice (of which latter there still remained more than ten tons) were then carefully placed on a barge packed as before, and were towed to New Norfolk, twenty miles further up the Derwent than Hobart Town, by the steamer 'Emu,' which was detained till a late hour on the night of the 20th on purpose. From New Norfolk the barge was towed by boats to the falls three miles further up the river on the morning of the 21st; and the packing-cases were then landed and slung on stout poles and carried by hand to the ponds already prepared at the river "Plenty," three miles further up. The remaining ice was transferred to the ponds in carts, the contents of each being well covered with straw. The first batch of cases arrived at the ponds about the middle of the day on Thursday the 21st of April, 1864, ninety days after the placing of the ova on board the 'Norfolk.'

On their arrival, Mr. Ramsbottom immediately proceeded to prepare the gravel-beds for the reception of the ova. A slight description of the ponds is here necessary. These ponds are twenty-six miles from Hobart Town, and were arranged in accordance with designs brought from the Stormontfield establishment on the Tay. Water is led from the river Plenty by a race to a small plot of grass-land above flood-mark. Sluices are placed on this race to regulate the supply of water. From the main race a smaller one leads directly into the clearing-pond, which is circular, about five feet deep, and forty feet in diameter. Thence the water is led by two covered wooden troughs into an open wooden trough at right angles with the covered troughs. From the open wooden trough small sluices let off the water in any quantity desired directly into the gravel hatching-beds. These consist of wooden boxes about 5 feet long by 2 feet wide. There are twelve of them, arranged in four rows. The water passes with a slight fall into the upper end of the first box in each row, over the lower end of that box into the upper end of the second box, and so on to the lowest, where the water from each row passes over a series of shallow gravelly pools to a pond about 120 yards long and 40 feet wide, varying in depth from 2 to 9 feet. All the surplus water from the clearing-pond also finds its way into this larger pond by a covered drain, ensuring a permanent supply of clear cool water. All the entrances to and exits from the pond and hatching-beds are carefully guarded by covering them with perforated zinc. As the day on which the first of the ova arrived at the Plenty was warm, with a

bright sun shining, a tent was erected over the gravel-beds, the temperature of the water in which was found to be 55° Fahr. Ice was then freely placed in the transverse open trough at the upper end of the gravel-beds and the temperature thus reduced to 44°. About four o'clock on Thursday, the 21st of April, the first box of ova was opened, and, to the dismay of Mr. Ramsbottom, a very large proportion of the eggs were dead; but in the second and third boxes affairs looked more hopeful, and by the time a dozen were unpacked it was manifest that a large proportion would be saved. In unpacking, as soon as the lid of each box was unscrewed, the top layer of moss was quickly removed, and the lower layer of moss with the ova was then lifted out, and at once turned upside down on to the cool water running over the gravel-beds. By this means the ova soon separated from the moss, and distributed themselves amongst the gravel, after which the moss was carefully removed bit by bit. The unpacking was continued by candle-light through a great portion of Thursday night, and was renewed at daylight on Friday morning. By Friday night the last of the boxes were finished, and Mr. Ramsbottom calculated that about 35,000 living and healthy ova were safely deposited. Of these, only about 300 were Trout-ova, which were placed in a separate gravel-bed constructed on purpose and closed at each end by perforated zinc. The percentage of living ova varied greatly in the different boxes; but the largest number were invariably found in the boxes in which the ova were more thinly scattered amongst the moss, and had been subjected to only just enough pressure to keep them steady.

During the unpacking on Thursday night several living ova were unavoidably picked out and left in the heaps of damp moss beside the gravel-beds through the night. On searching the heaps of moss on Friday morning, several ova were recovered from amongst the moss, and one or two from the stones underneath, and transferred safely to the water.

Bedded in the moss of one of the boxes an English Wasp was found, which evinced slight signs of animation. On placing the insect in the sun for a few minutes it became quite lively and walked quickly away. It is true that wasps are scarcely desirable subjects for acclimatization, but surely this circumstance ought to teach us a useful practical lesson as to introducing valuable insects and other similar organisms, especially in their embryonic stages.

A few of the boxes of ova had been placed in the vaults of the Wenham-Lake Ice Company for six weeks before the 'Norfolk' sailed; and in these boxes, though a larger percentage of ova were dead, the eyes of the fish were distinctly visible in those which were living, the development of the embryo having reached a higher stage.

Before the whole of the ice was used up, the temperature of the water of the river Plenty fell to 42°, and averaged about 47° for some time afterwards. The only object in cooling the water with ice at first was to prevent the transition of temperature being too sudden. For several days after the deposition of the ova Mr. Ramsbottom was busily engaged in removing all dead ova and pieces of

moss, charcoal, &c. from the gravel-beds; and for some time afterwards the average death-rate was a mere fraction; but it increased as the hatching approached.

On the 4th of May, 1864, Mr. Ramsbottom had the high gratification of seeing the first Trout burst its egg in Tasmanian water, and on the following day the first Salmon.

The ova continued to hatch until the 15th of June, 1864, by which time Mr. Ramsbottom (then appointed Superintendent at the ponds) estimated the number of young Salmon at about 3000, and of young Trout at about 50. There are two reasons for the vast difference between the estimated number of living ova and the number of hatched fish:—one, that a large percentage of the most healthy-looking ova turned out absolutely barren through defective impregnation; another, that a large number of deaths occur at the very point of hatching, the embryo dying without being able to free itself from the egg. Early in August the perforated zinc guards at the lower ends of the breeding-boxes were removed and the Salmon-fry permitted to drop down with the stream into the shallows at the upper end of the large Salmon-pond, whence they gradually found their way to the pond itself.

By the end of August several of the Trout (all of which, up to this time, had remained in the trough in which they were hatched) died, and many others showed symptoms of disease. As no cause could be traced for this mortality, a gravelly rill was constructed at the upper end of the clearing-pond, and the entrances to and exits from the whole were guarded with perforated zinc. The Trout were then transferred to the rill; and it was ascertained that so many had hidden away under the gravel that, instead of 50, close upon 300 young fish were counted. In the clearing-pond the young Trout continued to thrive, and grew amazingly, no deaths being observed. Amongst the Salmon the mortality was, up to this time, trifling, being confined to such few weak fish as were driven against the perforated zinc guards and had not strength to fight against the stream.

On the 4th of October, 1864, a leak was discovered, by which a large run of water found its way from the Salmon-pond into the Plenty; and, fearing lest the Salmon should have been escaping, the Superintendent placed a box in such a manner as to intercept any fish passing through. One was soon found in the box, and an attempt was unsuccessfully made to remedy the leak. From the 7th to the 25th of October a trench was cut across the place where the leak occurred, and the defective place puddled, and the leak ultimately stopped; but during these nineteen days 240 fry were captured which had passed through, and it is certain that a very large number had previously reached the Plenty.

Till March 1865 everything continued to progress in a satisfactory manner at the ponds; the young fish, which had been at first supplied with boiled liver powdered fine, were now almost entirely fed on gentles, and up to the 10th of March exhibited all the appearance of vigorous health. From the 10th to the 15th of March no less than forty parr died: all of them appeared plump, well-grown

fishes; and it was difficult to assign any reason for their deaths. Owing to an unusually hot and dry autumn, the Plenty was very low, and the temperature of the water rose above its ordinary summer heat. This may have been the cause of the mortality, especially as the Salmon-pond then consisted almost entirely of still water; and the Commissioners therefore determined to liberate the bulk of the parr at once. Up to the 19th of March nine more fish died; and on that and the two following days the pond was lowered, and 419 Salmon parr were liberated into the River Plenty, half a mile above its junction with the Derwent.

Fourteen of the smallest fishes caught were retained in the pond; and a number which could not be caught, and of which number no accurate estimate could be made, still remained. Many of the parr liberated exceeded 5 inches in length, being then ten months old.

Every thing progressed favourably from the end of March; and on the 23rd of October, 1865, the first fish which had assumed the Smolt dress was seen in the Salmon-pond, and between that time and the end of the year thirty-three fine Smolts were liberated. In January, 1866, some alterations were made in the clearing-pond; thirty-eight Trout (*Salmo fario*) were then liberated into the Plenty, 133 being returned to the pond.

The Tasmanian Government, encouraged by the success of the attempt in the 'Norfolk,' determined to obtain a second shipment, that no chance might be lost of rapidly carrying the undertaking to a successful issue; and on the 8th day of February, 1866, the ship 'Lincolnshire' left Plymouth bound for Melbourne, having on board about 103,000 ova of Salmon (*Salmo fario*) and 15,000 ova of Sea-trout (*Salmo trutta*) stowed in an ice-house of rather larger capacity, but of much the same construction as that built in the ship 'Norfolk' for the same purpose two years before. The whole of the arrangements for shipping were superintended by Mr. James A. Youl, who again exhibited the determined zeal upon which so much depended in the former experiment. The method of packing the ova in the boxes and the boxes in the ice-house was identical with that adopted in the 'Norfolk.' After a rather long passage of seventy-nine days, the 'Lincolnshire' arrived at Hobson's Bay on the 30th of April, 1866, and the ova and ice were at once transhipped to the steamship 'Victoria,' again most liberally placed at the disposal of the Tasmanian Salmon Commissioners by the Victorian Government, and arrived in the Derwent on the 4th of May, and by 8 P.M. on the following day the last of the ova were placed in the hatching-boxes at the Plenty, the water, by the help of the remaining ice, being reduced to 45° F.

One remarkable fact in this experiment was the forward state of the larger portion of the ova, the fish being distinctly visible, furnishing abundant proof that a large number, at any rate, had been successfully impregnated. This was especially observable in the Sea-trout, the pupils of the eyes in which last stood out as black spots on a yellowish-white ground, the enveloping tissue being more transparent than in Salmon-ova.

The proportion of living ova deposited was estimated at above 45 per cent. of all sent out. Since the deposition of the ova in April, 1864, several great improvements had been effected by the Commissioners in the arrangements at the Plenty, the chief of which was the alteration of the gravel in the breeding-boxes. To explain the change and the advantages of the present plan, it must be remembered that in its own rivers the Salmon chooses for its spawning-beds shallow rapids running over a bottom of coarse river-gravel, consisting of pebbles weighing from half a pound to three or four pounds, the spaces between which are of course large enough to permit the ova to roll down to depths varying from a few inches to a foot and a half. This is no doubt a wise provision of nature for the protection of the ova and the helpless young fry from their innumerable natural enemies, but has serious objections in artificial rearing. To begin with, it is absolutely impossible, in the first instance, to separate the dead from the living ova; all must be rapidly transferred to the water together, and the dead ova gradually picked out afterwards. In 1864 numbers of dead and living ova together got out of sight between the interstices of the gravel purposely made to resemble as nearly as possible the natural spawning-beds, and much of the living ova was assuredly destroyed by contact with that which was decomposing, to say nothing of the ill effects which the decaying ova would have upon the water generally. Again, it is now an ascertained fact that a considerable admixture of atmospheric air is indispensable in hatching the ova of most of the Salmonidæ, and that, consequently, the further the ova are from the surface of the water, the more tumble and splash you must have in the water to drive bubbles of air through and amongst the gravel. It follows that if in artificial rearing the ova are allowed to get some 3 or 4 inches down into the gravel, a sharp stream of water must be directed over the artificial beds to supply them with the air necessary—but that if it is desired to keep the ova in sight, they must be placed on fine gravel, and an even, gentle stream of water about an inch or an inch and a half in depth must flow through the beds. As in the artificial process the boxes are thoroughly guarded from all possible enemies, the advantages are so manifestly in favour of keeping the ova in sight, that the Commissioners replaced the coarse gravel formerly used by an even bed of very fine pebbles on which the ova rested about an inch from the surface of the stream, which was made to flow gently and evenly through the boxes. The result was, that the moment an egg became opaque, or, in other words, died, it was removed, and all danger to the neighbouring ova was avoided. Besides this alteration, a long series of gravelly rapids, with a few deep places interspersed, was added to the lower end of the Salmon-pond, and a new circular pond with a gravelly rill attached was constructed for the Salmon-trout.

On the 8th of May, 1866, the first Salmon-ovum per 'Lincolnshire' hatched, and on the 12th of the same month the first Sea-trout ovum. By the time all were hatched the Superintendent reported that he had counted up to 4490 Salmon-fry and 496 Sea-trout fry,

and estimated those he had been unable to count of the Salmon-fry at about 1500.

In July, 1866, all the remaining parr, seventy-seven in number, of the shipment per 'Norfolk' were liberated; and every fish showed distinctly the approaching change to the Smolt form.

On the 3rd of July ova and milt were taken from the first pair of Trout (*S. fario*) which ever arrived at maturity in Australia. By the 7th of August fourteen females had been stripped, yielding about 4050 ova. Shortly afterwards five pairs of Trout (ten of the thirty-eight fish turned into the Plenty) were observed constructing rids in that river. The Trout in the river were considerably larger than the largest in the clearing-pond, though several of the latter weighed more than a pound each.

During July and August, 1866, a large number of deaths took place amongst the fry from the last shipment of ova; the total loss being 470 Salmon-fry and 65 Salmon-trout fry.

On the 30th of September, 1866, the Trout-ova taken from the fish in the clearing-pond commenced hatching; but a large number of eggs proved barren.

During August the fry, both of Salmon and Salmon-trout, *ex* 'Lincolnshire,' were permitted to escape into the large pond and the rill attached, with the exception of a few pairs of Salmon-trout, retained in the pond and rill purposely constructed for them in the hope that spawn might be obtained without the previous migration to the sea. From the end of September the operations at the ponds were simply repetitions of what had taken place with regard to the first experiment, some variety occurring through the addition of the Salmon-trout and the occasional capture of large Trout in the Plenty. One was taken on the 13th of January, 1867, 17½ inches in length and weighing three pounds.

Although the bulk of the Smolts of the first shipment left the river in October and November, 1865, and should, according to most authorities, have returned as Grilse in the February following, no report reached the Commissioners of any thing resembling Grilse having been seen. Mr. Ramsbottom always maintained that the Smolts did not return as Grilse in three months, but that they would return in one year and three months; and so convinced was he of the correctness of this view, that he made no systematic watch for the fish in 1866. The mere fact that no report of the fish being seen reached the Commissioners by no means proves that they did not return in February 1866; for it must be remembered that, under the most favourable view of the case, not more than 1000 or 1500 Smolts can have left the Plenty, and were thenceforth distributed over a river but little smaller than the Severn in England, and into which numbers of large tributaries, admirably suited for Salmon, emptied themselves.

In February and March 1867 fifteen persons, including Mr. Ramsbottom, reported that they had seen Salmon or Grilse in the fresh waters of the river Derwent. Several of these witnesses were gentlemen of high respectability; and it is impossible to conceive that

they could have been mistaken, because no indigenous fish in the fresh waters of the Derwent (except Eels) ever exceeds one foot in length or weighs more than three-quarters of a pound.

Mr. Ramsbottom began early in February 1867 to walk morning and evening from his house to the Derwent and back (more than two miles each way) to one likely spot, keeping a regular systematic watch for the Grilse; and the following extract from his journal of March 15 will serve to show the deep interest he took in his work.

"It is with feelings of thankfulness that I can now say I have this day seen a Salmon in the Derwent.

"This morning, after an early breakfast, I started off, for the sixty-ninth time, to the river to look for Salmon. At about 10 A.M. my assistant, J. Stannard, came to me at the Dry Creek and told me that Lumsden (water-bailiff) had seen no less than half a dozen Salmon playing about in the long pool where he was on the look-out this morning. This joyful news again put new life into me; and I at once started off for the spot, as I now meant to see a Salmon if one was to be seen at all during the day. At a little before 12 I took a seat on a log which is in the river about 15 feet from the side, in order to command a good view; here I sat for about two hours under a burning sun, when I heard a kind of rush behind and rather below me. I looked round, and saw it was the motion of a large fish, but could not persuade myself it was a Salmon. In twenty minutes more I saw the partial rise of a fish, head and breast out of water, but could not be sure yet as to whether this was a Salmon or not, as the fish rose at too great a distance from me, and did not make the same splash in the water as I thought a Salmon ought to do; yet the fish looked larger than any I had before seen in these waters, so that I now got very uneasy in mind, sometimes doubting, and at other times believing, they must really be the Salmon; and in this excited and perplexed state of mind I was kept until 3.40 P.M., when, to my exceeding great joy, I was delighted to see nothing else but a Salmon jump clean out of the water, show himself broadside on; and, judging from his appearance, I should call him a Grilse of about 5 lbs. weight. On seeing the Salmon, it is impossible for me to describe my joyful feelings."

Three days afterwards (on the 18th of March) Mr. Ramsbottom saw seven fish rise in the pool above mentioned, two of which he stated positively were Salmon. On the 17th of June, 1867, a large male Trout was found dead in the Plenty. It was a spent fish, much knocked about probably by fighting with other males: it measured 19½ inches in length, and weighed 3½ lbs. This fish was just three years old.

During June, July, and August of 1867 the Trout (*Salmo fario*) were again stripped of their spawn artificially, about 11,500 ova having been taken from forty-seven fish. After this spawning several of the spent fish were killed and eaten by a family of Yellow-bellied Beaver-rats (*Hydromys chrysogaster*) which found their way to the rill, but which were ultimately trapped and destroyed.

A large supply of this season's Trout-ova was sent to Victoria and

New Zealand; and on the 14th of September the residue commenced hatching. About 2000 young fish were ultimately distributed from this source amongst suitable streams in various parts of Tasmania.

A report having reached the Commissioners that Salmon had been seen at Dunrobin, thirty miles further up the river than its junction with the Plenty, Mr. Ramsbottom was despatched to the spot, and learnt that a young man, a native of the colony, who knew nothing whatever of Salmon, had a month before stated to his employer that he had seen a pair of very large fish on one of the shallows of the river. Mr. Ramsbottom questioned this young man very closely; and his accurate description of what he saw left no doubt on Mr. Ramsbottom's mind that a pair of Grilse had actually spawned in the upper waters; and though the river was too high from recent rain to find the rid, the spot pointed out was one as well suited for spawning-ground as any in the world.

On the 19th of October (the majority of the parr hatched from the shipment of ova per 'Lincolnshire' having assumed the Smolt dress) the perforated zinc obstructions were permanently removed; and such of the fish as chose to leave found their way from time to time into the Plenty, and thence to sea.

On the 10th of November, 1867, Mr. Ramsbottom left the ponds at the Plenty with 270 Trout-fry in an apparatus of his own arranging, and landed in Melbourne on the 15th with 248 living fish, a feat in pisciculture which had probably never been surpassed, and which again proved his peculiar fitness for the position he filled. During the months of February and March 1868 the river Derwent was unusually high, heavy rains having fallen upon the mountain-ranges in which its western tributaries rise; and partly on this account, and partly on account of the serious illness of the Superintendent (Mr. Ramsbottom), no regular watch was kept for the return of the fish: two or three reports only of their having been seen (one from an authentic source) reached the ears of the Commissioners.

On the 27th of June, 1868, a Trout (*S. fario*) was caught in the Plenty, 26 inches long, and weighing $9\frac{1}{4}$ lbs.

As a large number of the Trout-ova artificially taken during the seasons of 1866 and 1867 proved barren, whereas the eggs naturally deposited in the rill almost invariably contained fish, it was determined to remodel the rill at the upper end of the Trout-pond, and to make it resemble as nearly as possible a series of natural spawning-beds. This was done, and a temporary fence was erected down each side as a shelter, from which the fish could be observed and to prevent their being disturbed while on the spawning-beds. During the winter of 1868 no spawn was taken artificially, but the whole of the Trout were left to their own devices. For more than a month pairs of fish could be seen day after day making their rids and depositing the ova. When the last of the fish had spawned, a perforated zinc guard was fixed across the lower end of the rill, and the old fish thus prevented from leaving the Trout-pond and interfering with the ova or young fish. Large numbers of the ova being required for distribution in Victoria, New Zealand, and Tasmania, the water in

the rill was occasionally lowered, a rid or two opened, and the ova carefully picked out by means of a curved glass tube. Scarcely a dead egg was found; and from one shipment of 800 ova sent to New Zealand, 750 fry were liberated at four months old. In due course the rill became alive with thousands of Trout-fry, which were distributed in numbers of suitable streams and lakes in divers parts of Tasmania. Another large shipment of Trout-fry was also successfully transported to Victoria in Mr. Ramsbottom's apparatus, under the personal superintendence of Mr. John Buckland, one of the Salmon Commissioners, who, out of 226 taken from the ponds, delivered 225 healthy fish to the Acclimatization Society in Melbourne, thus accomplishing even a greater feat than that performed by Mr. Ramsbottom the year before. During this season the numbers of fish seen spawning in the Plenty were amazing; and for several miles up the river, rids were to be seen on every suitable spot. Some of these rids were from 8 to 10 feet long, and must have been formed by enormous fish.

During the winter of 1868 Mr. Ramsbottom, who had long been suffering from lung-disease, became much worse, and sailed for Sydney on leave of absence, in the hope that the change might benefit him; but he died in September, universally regretted by all who knew him or took any interest in the Salmon experiment. In reporting the death of their excellent Superintendent to the Government, the Salmon Commissioners unanimously expressed their sense of his great merit and the loss which they and the enterprise in which they were engaged had sustained in his death.

In October 1868 the residue of the parr brought by the 'Lincolnshire' put on their silvery scales, and took their departure from the pond seawards in the form of Smolts.

During the summer of 1868 and 1869 reports of Salmon or Grilse having been seen were numerous; and in March of the latter year, the river being low and bright, the fish were seen so frequently at a favourite pool near the entrance of the Plenty, that numbers of people used to spend the evening watching for them; and on one occasion no less than twenty people were gratified by seeing several large fish, which could only be Salmon, sporting on the surface and occasionally breaching above the water. Amongst others, several residents on and near the river, who had always been most sceptical as to the presence of Salmon in the Derwent, became converted, and strongly condemned in others that disbelief which they themselves had fully concurred in but a short time before.

At this time the Commissioners and others made many unsuccessful attempts to capture a fish that had returned from the sea. The cause of failure can be readily understood by any one who has seen a large river, the banks of which are, for the most part, in a state of nature. There being an absence of large indigenous fish, no motive has hitherto existed for clearing the dead timber from the stream or the living scrub from the banks; and before either the angler or the net-fisherman can ply his calling successfully, considerable expense must be incurred in preparing suitable stations. It might be thought

that at any rate it would not be difficult to hook a fish, even if it could not be landed; but it must be remembered that the fish to be caught were yet few in number, and that small indigenous fish swarm in myriads, furnishing such a supply of food that no bait will be likely to tempt the Salmon till this profusion is somewhat thinned. It is possible that Grilse or Salmon might have been taken in the tidal waters between Hobart Town and New Norfolk, a great part of which has been and could be worked with seine nets; but the local fishermen had so denuded the river of indigenous species of fair size by excessive netting at all seasons, that they had been for several years compelled to use nets of so small a mesh that even a Smolt could not pass through; and rather than run the risk of sacrificing the whole experiment by the destruction of any of the small consignments of Smolts sent seaward, the Commissioners exercised the power given them by the Legislature, and closed the river above Hobart Town altogether from the time the first batch of Smolts entered the brackish water. All attempts to take fish having failed, when the first rains of winter came on and the fish proceeded further up the river, the Commissioners came to the conclusion that the first undeniable proof they should now get of the success of the experiment would be the capture of Parr or Smolts in the coming spring, as such Parr or Smolts could only be the progeny of fish returned from sea, the last of the Smolts from the transported ova having left the ponds in the spring of 1868 and being therefore either dead or approaching grilsehood.

In June 1869 the Trout again commenced spawning in their rill; and towards the end of the same month five pairs of the Salmon-trout (*Salmo trutta*) formed rids on the shallows attached to their pool, which shallows are now, in October, alive with their fry. The success of this portion of the experiment may therefore be considered as complete as that of the Trout (*S. fario*), as a noble river, the Huon, has been purposely left unstocked, with the intention of turning into it all the Salmon-trout fry except those retained for a breeding-stock.

About the middle of October 1869 a strong freshet came down the Derwent, the result of heavy rains at its sources; and on the night of the 21st of October four fishermen were hauling their seine on a sea-beach about two miles below Hobart Town, and on the opposite side of the estuary of the Derwent. At one of the hauls almost the only fish in the net was a well-grown healthy Salmon-smolt over 10 inches in length, and which, though taken in water as salt as the ocean, had but lately left fresh water; for the silvery scales rubbed off at the slightest touch, showing the colouring of the parr beneath. Half an hour later, and on a beach a mile nearer the town, a second Smolt, not quite so large as the first, was captured. The seine net used was a large-meshed one of an inch from knot to knot, which accounts not only for the capture of a single Smolt at each haul, though they are usually gregarious, but also for the unusual size of the specimens; the probability is that the net had in each instance surrounded a school, but that the ordinary-sized fish had easily passed through, while these two, larger

than their brethren, had been dragged out. The fishermen, well knowing that these were not indigenous fish, made a shrewd guess at the nature of their capture, and, on the 22nd of October, brought them to the Salmon Commissioners, who at once pronounced them veritable Smolts*.

Before concluding, it may be well to state that the whole of the expenses hitherto incurred in the conduct of the experiment between January 1860 and October 1869 amount to £8835 12*s.* 2*d.* Of this sum, £6990 11*s.* 2*d.* was paid by the Tasmanian Government, £995 1*s.* by the Victorian Government, £200 by the Acclimatization Society of Victoria, £300 by the Provincial Government of Canterbury, New Zealand, £200 by the Provincial Government of Southland, New Zealand, and £150 by the Provincial Government of Otago, New Zealand. Credit must also be given to the Victorian Government for the large amount which must have been expended in freight had not H.M.C.S.S. 'Victoria' been twice so liberally placed at the disposal of the Tasmanian Salmon Commissioners.

4. Additional Memoranda as to Irregularity in the Growth of Salmon. By James Murie, M.D., F.L.S., Prosector to the Society.

(Plate II.)

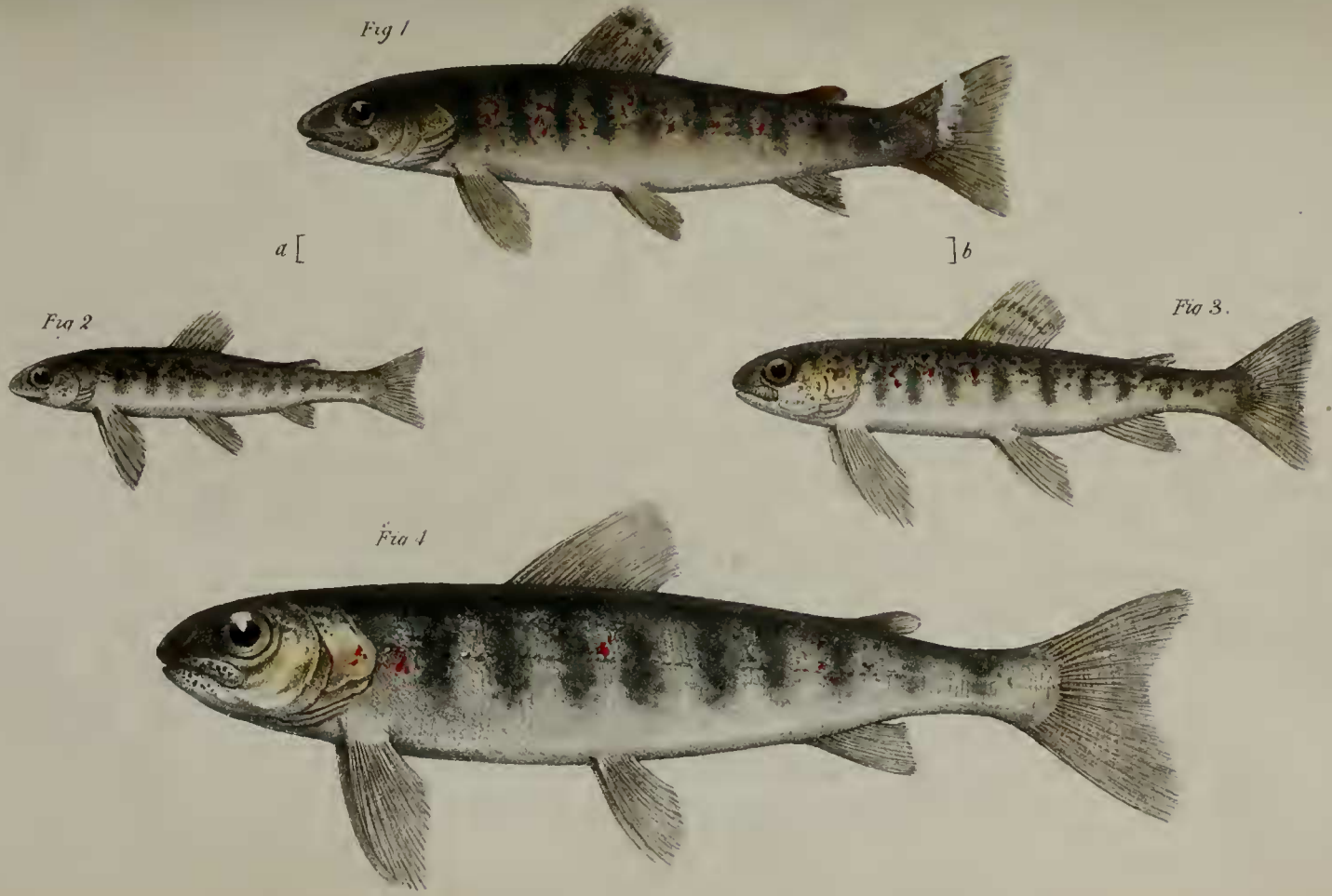
Preliminary Notice.

When I communicated to the Society some observations in connexion with the supposed arrest of development of the Salmon (see P. Z. S. 1868, p. 247), I purposely held back memoranda in support of the view therein enunciated. Having, as it were, registered the data occurring within my own ken, my further intention was to institute a series of experiments, with the object of crucially testing the truth or fallacy of the doctrine.

Unforeseen circumstances happened, depriving me of that auxiliary assistance necessary for the fulfilment of the requisite conditions. But it is probable that other parties may be favourably placed to try the issue of experiments, to set the matter at rest; hence I make note of what seems a feasible plan.

I propose that some one resident close to a Salmon river should obtain a quantity of impregnated and undoubted *Salmo-salar* ova—some of this to be forwarded, and deposited in the tanks at the Gardens, where, after hatching, careful notes of the growth and changes &c. are to be made; due precaution also to be taken that batches of the young fish shall be placed under varied circumstances, *i. e.* as respects the size of the reservoir, food, &c.; on the other hand, the

* [One of these "Smolts" was sent home to be exhibited when the present paper was read, but upon being submitted to Dr. Günther's examination was determined by him to be a dwarfed example of *Salmo trutta*, and not a *S. salar*. —P. L. S.]



C Berjeau del et lith

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SALMONOIDÆ

remainder of the ova left in charge of the correspondent to receive widely different treatment—hatching to be carried on in the open air, and the tiny fish, once out, confined in a pond. Reared to the Smolt condition, when the migratory restlessness occurred, some might be marked and allowed to go seaward, the condition of those left behind being noted. During the second or third season, as the case might be, others to be allowed to depart, whilst a few are permanently retained in the pond.

Three years or less from the commencement of the experiment, in the event of a marked grown Grilse or Salmon being caught, specimens from the Society's tanks, the open-air pond, and it to be rigidly compared side by side. In the intervals specimens of the progressive ages and stages to be preserved in spirits, and, as apparent changes take place, figures and annotations thereon duly registered.

The result of experiments conducted somewhat in the above fashion would, I consider, conclusively prove whether or not Salmon are temporarily or definitely arrested in their development when retained for a considerable period in fresh water. At all events all chance of the denial of the parentage of the fish would be obviated.

Or, again, if the breeders of Salmon, say at the stock-ponds in Perthshire, could be induced to fertilize the ova of a full-grown Salmon, and transmit the same to the Society, I venture to say the ova would be attentively watched during the process of hatching, and afterwards the phenomena and stages of growth duly recorded. Furthermore, could the bodies of the parents, male and female, be likewise transmitted to London for identification, all possibility of error would be prevented. As appears plain from what has happened with those already reared in the Zoological Gardens, it is of the utmost importance that the parents should bear witness of the ova being those of genuine *Salmo salar*.

It is, indeed, much to be desired that some such well-attested observations should be pursued; for notwithstanding the asseverations of several trustworthy observers, subsequently to be cited, there still remains a lurking suspicion that error of data may have crept in.

I urge therefore upon pisciculturalists, and such as are interested in solving a physiological, or, rather, zoological problem of high value, the benefit science would derive from the authentication or denial of the alleged circumstantial evidence. This is my plea for intruding the above suggestions and further memoranda upon the Society. I trust that this second notice may stir up those at home, or fish-rearers abroad, to follow out the investigation.

I may premise that I have not entered on the task in a controversial mood, but to incite further research on the matter. Moreover it is possible those interested in the question may wish to refer to the data, be they merely asserted or be they proven, concerning the rearing and detention in pure fresh water for so long a period of fish considered to be Salmon.

It may be pardonable on my part, then, to examine more narrowly than heretofore the grounds of opinion, favourable or adverse, especially as the whole matter is one involving biological laws of the

highest consequence as regards the determination of species, supposed transition of allied forms, and questionable hybridity.

With these remarks I proceed to reproduce my previously suppressed discussion of facts and published data.

Affirmation.

I. *The historical evidence.*—What points to the truth of this (*i. e.* that the fish described are Salmon) has already been given (see P. Z. S. 1868, p. 247); but it undoubtedly contains a weak point; otherwise the whole matter were settled. While the ova received in the Gardens on the 8th January, 1863, may have, as related, veritably undergone all the subsequent changes ascribed, this does not prove their being in the first instance ova of *Salmo salar*. Messrs. Buckland and Bartlett assume them to have been so, and add validity by stating that the size and appearance of the ova convinced them of their genuineness; for the ova of the Great-Lake Trout differ sufficiently to be recognized by the naked eye.

As a sequel to the heretofore described specimens, it is most important to note that one of the fish produced from the ova of the Rhine Salmon, hatched in the Gardens in February, 1863, died on the 1st December, 1867. It was sent to Mr. Frank Buckland, who found on examination that it was a pregnant female. He states that 117 ova, nearly ripe, were present in the abdominal cavity, lying perfectly loose therein. This female weighed 4 oz., and measured $8\frac{1}{2}$ inches in length. Mr. Buckland believes "that, had this fish lived another fortnight or three weeks, these ova would have been quite fit to be deposited in a nest, after the fashion of an ordinary full-grown salmon that had made its two or three journeys from the fresh water to the sea" *.

II. *External resemblances to Salmon.*—It can hardly be denied that, so far as external appearance is concerned, the fishes bear the stamp of young Salmon in the Parr condition. This applies more especially to that figured as No. 1 (Pl. xxiii. P. Z. S. 1868); the other, No. 2 (*l. c.*), is more brindled and spotted than is commonly the case in the Parr; but this in part may be due to the nature of its habitation. The form of the bodies, the relative dimensions of snout to head, head to body, shortness of maxillary, colour of adipose fins, dentition, shape of caudal fins, and contour of præoperculum all agree with *Salmo salar*, and not with other species of *Salmo*.

III. *Published statements and experiments.*—Reference to a few of the better substantiated cases of Salmon reared and continuously kept in fresh water may be interesting at this juncture.

1. Yarrell (Brit. Fishes, vol. i. p. 172, 3rd edit. 1859) mentions that a Scottish landed proprietor in 1831 put some Salmon-fry into a freshwater pond. These were taken out in 1833, to all appearance

* See an account of this interesting specimen in 'Land and Water' for Dec. 7, 1867, vol. iv. p. 320. Preserved in spirits as a preparation, this same fish was shown at the Meeting the evening the former paper was read. It now forms one of the series in the Museum of Fish-culture at the Horticultural Gardens.

Salmon. They weighed from 2 to 3 lbs. each; their flesh was pale in colour.

2. The same acute naturalist has published a separate volume 'On the growth of Salmon in Freshwater' (1839), wherein six coloured illustrations of fish of the natural size, at various stages during the first two years of their growth, are given. The specimens figured show very well the progressive growth and change of dress with age. Yarrell remarks that there is a comparative deficiency of general growth in the older specimens. One of the largest measured 14 inches long and weighed 14 ounces.

3. Lloyd states that near Katenberg there is a salmon-fishery. "These salmon are bred in the lake, and, in consequence of cataracts, cannot have access to the sea." They are small in size and inferior in flavour.

4. I may as well here quote the opinion of another eminent Scandinavian pisciculturist, Prof. Rasch, of the Christiania University. Writing to an English friend *, among other matters he says, "The assertion of some of your countrymen that the Salmon cannot be acclimatized so as to become entirely a freshwater fish is quite at variance with the results of experiments we have made in Norway. Some years ago Hetting hatched out numbers of Salmon-ova, which he subsequently turned loose in the Tyri-fiord; and during the last two years fish have been caught in that lake, resembling in every respect 'Salmon proper.' It is impossible for them, as you know, to return thither, even should they succeed in reaching the sea.

"As regards acclimatizing Salmon to fresh water, our enclosures at Greffsen† are too small. But if in larger pieces of water it be only possible to prevent their first migration to the sea after they have assumed the Smolt dress, they will readily accustom themselves to their freshwater home. And should the water be a very large lake, such as Ladoga, Werner, Peipus, and as rich in nourishing food, the freshwater Salmon will then attain about the same size as the Salmon of the sea."

5. Mr. George Anderson, of Glasgow, communicated the following authentic case to the 'Field' (see 23rd and 30th June, 1866)‡. This gentleman obtained in 1862 about thirty specimens of Salmon parr from the well-known Stormontfield Salmon-ponds §. The fish, as he observes, were then two years old, but had not put on the Smolt dress preparatory to migration.

Twenty-nine of the Parr were placed in a freshwater pond well supplied with Minnows and other food. In June 1866 the pond

* Who, under the initials "N. R. B.," has published the letters in 'Land and Water,' vol. i. pp. 221–245 (March 31st and April 7th, 1866).

† An establishment close to Christiania.

‡ I am indebted to Mr. Charles Darwin for calling my attention to this interesting notice.

§ A pretty sure guarantee that the fish were the young of *Salmo salar*, as it is not at all likely that the trained eyes of Mr. Buist and other experts would be deceived in them—nor, indeed, that ova specially destined to stock the river Tay, and not, as in Huningue, exported, should be chosen from other than pure-bred Salmon.

was run off, when three good-sized Salmon were found to have survived; these were bright, lively, and healthy, but ill-grown. One of these specimens sent to London weighed 15 oz., measured $14\frac{1}{2}$ inches in its greatest length, and had a girth of $6\frac{1}{2}$ inches. The head was $3\frac{1}{8}$ inches from the snout to the extremity of the operculum, and appeared large enough for a 5-lb. fish.

It is greatly to be regretted one of these three unusually interesting specimens was not preserved in spirits and forwarded to the British Museum.

6. Lastly, I shall advert to an account, by Mr. Frank Buckland, of a "Salmon that had never seen the sea"*. This specimen was obtained from the river Wye in 1862, in the Parr condition, and transferred to a pond through which a streamlet of water ran. Four years afterwards it was taken out as a Salmon 11 inches long.

IV. *Irregularity of growth.*—The life-history of *Salmo salar*, as all admit, is a most extraordinary one. The exceeding rapidity of their growth between their descent to and return from the sea is marvellous. But there are still two points as remarkable, viz. that a retardation of development is far from uncommon; and, on the other hand, causes occasionally ensue seeming as it were to stimulate and quicken the usual accession of growth. Since Shaw's experiments on the growth of Salmon-fry †, other observers have noted, and, in fact, it is now universally known to all those practically conversant with artificial Salmon-culture, that of the first year's Smolts only some migrate seawards, while many of them remain behind in the fresh water. In the second year it also occasionally happens that in some fish no desire of migration ensues; but the accession of migratory instinct takes place in the ensuing season, or even later. In other words, some Smolts ripen earlier than others, and those remaining behind, which are slower in their seasonal migratory instinct, remain apparently stationary as to growth. The cause of the retardation of the migratory stimulus, so far as I am aware, has not been satisfactorily accounted for; but clear evidence exists that the young self-detained Salmon are little or no larger than their brethren a year or two younger. Their development is more or less retarded for the time being—but not necessarily continuously so; for as soon as migration occurs, the usual growth concomitant with a sea-water visit takes place. Here, then, we have, from natural causes, retention and arrest of growth of young Salmon in a comparatively healthy condition in fresh water for two years or more. If such a fact or premise be granted, it seems to follow, as a necessary consequence, that if Salmon arrived at the Parr condition be prevented from migrating, they either remain stunted or increase in magnitude in a very diminutive ratio compared with their fellows that have spent a season in the sea-water.

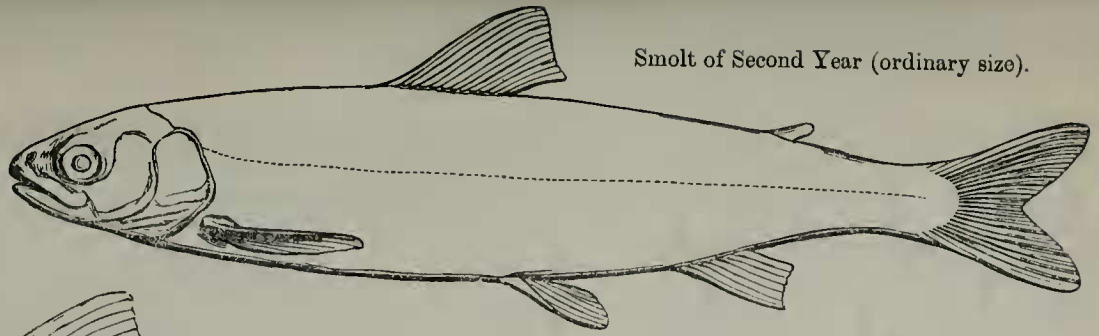
Regarding increase of size generally, and also unusual accretion of growth, in Salmonoids, this, as most authorities agree, is greatly, if not entirely, dependent on the abundance or scarcity of food,

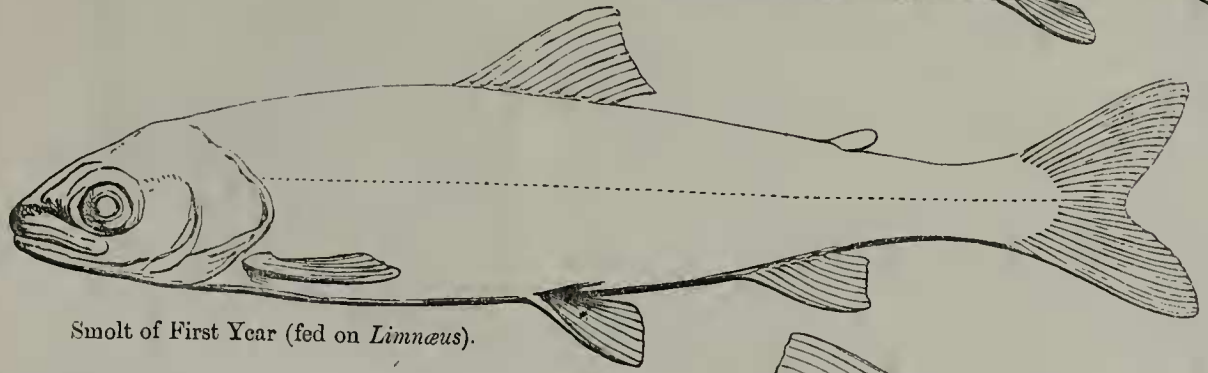
* Figured and described in 'Land and Water,' vol. i. June 2, 1866.

† Trans. Roy. Soc. Edinb. vol. xiv. &c.

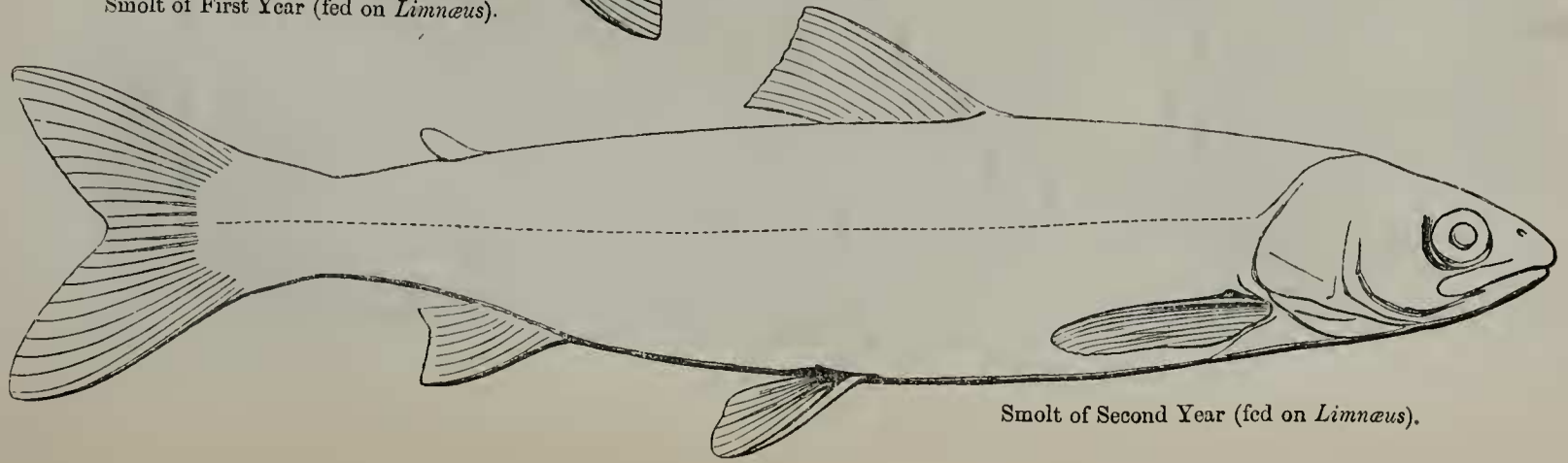
Young Fry.

Smolt of Second Year (ordinary size).





Smolt of First Year (fed on *Limnæus*).



Smolt of Second Year (fed on *Limnæus*).

and the extent of the water in which they abide. Many facts might be adduced in support of this ; but one of recent occurrence may serve the purpose of illustration*. The experiments at Stormontfield, in Perthshire, already adverted to, are too well known to need further comment ; suffice it to say that there can be little doubt of these ponds containing the produce of genuine *Salmo salar*. On the 20th of May 1868, at the above piscicultural establishment, "Peter of the Pools" (the *nom de plume* of an experienced Salmon-rearer) observed great variation in the size of the smolts of the same age—some of the two year-old fish being fully a fourth larger than others, and their bodies proportionally plump. This increased growth was found to be dependent on their feeding on molluscous animals ; for in the pond which the large Smolts inhabited vast quantities of *Limnæus peregra* had taken up their abode among the aquatic plants†.

Negation.

I. *Not true Salmon*?—I had Dr. Günther's permission to state that in his opinion the specimens reared in the Gardens (*cf.* P. Z. S. 1868, p. 247) are not true *Salmo salar*, as he considers their history a doubtful one, and furthermore, in some respects, they disagree with the characters assigned by him to that species. He justly lays stress upon the weak point that the ova may or may not have been the produce of a female *Salmo salar*, and may or may not have been impregnated by the milt of a male of the same species. He thinks that among the immense numbers of Salmon-ova yearly sent off from the hatching-establishment at Huningue on the Rhine, there is likelihood of mixture occasionally occurring in the transit, and also that fish which are not true Salmon may be mistaken for them and thus error arise. The chance that fortuitous circumstances might give rise to the last-mentioned error has already to some extent been admitted. It is well to remember, however, that Salmon-ova are distinguishable from those of the Great-Lake Trout, with which they may have been most readily confounded, by their greater size and deeper yellowish tint.

Now as regards constant characters defining the species, and thereby, by the absence of such, excluding the imperfectly developed specimens from being considered as representatives of *Salmo salar*, Linn., I shall take three into consideration—the number of the vertebræ, of the cæcal appendages, and of the scales ; the other six characters which Dr. Günther considers trustworthy in the classification of the Salmonidæ are not so applicable in the present instance. A tabular view, moreover, may be more readily appreciated ; hence I place in series the formulæ appertaining to true Salmon, our two specimens, and such forms as are the most likely to have been introduced into the Gardens and mistaken for Salmon. The formulæ are

* See 'The Field,' June 13, 1868.

† Through Mr. Tegetmeier's interest, the proprietors of 'The Field' have kindly permitted me the use of their woodcuts illustrating the phenomenon here cited (see p. 35).

taken from Dr. Günther's catalogue; but the upper and lower transverse or oblique series of scales are expressed here in separate columns, and the numbers within brackets are extremes incidentally noted in his description of typical specimens in the collection.

TABLE A.

	Vertebræ.	Pyloric appendages.	Scales.		
			Horiz. series immediately above lat. line.	Transv. series.	
				Dorsal fin to lat. line (obliquely).	Lateral line to ventral fin (obliquely).
Salmo salar	59	53–70	120	22–26	19–22
—— ——?, Zool. Soc. spec. No. 1.	59	48–50	120–122	19 (21?)	18
—— ——?, Zool. Soc. spec. No. 2.	60	.....	120	22	.....
—— trutta	59–60	[46] 49–61	120 [117]	24–26 [30]	36–34 [22]
—— cambricus	59	39–47	120–125 [117–130]	27 [25–28]	38–40 [20–24]
—— fario gaimardii	59–60	33–46	120 [124]	27–30 [26]	[22]
—— —— ausonii	57–58	38–47 [51]	120 [117–127]	26–30 [23–31]	[21–27]
—— carpio (Lake Garda)	.....	40–50	123	.....	.....
—— remanus (Lake Geneva)	57–59	45–52	115–128	26–28–36	.....
—— rapii (Lake Constance)	59–60	48–54	120	27–35	.....
—— lacustris (Lake Constance)	60–61	60–61	120	26–30	.....

Tested by the number of vertebræ, the doubtful specimens in question may either be *S. salar* or any other of the species enumerated, excepting *S. fario ausonii*.

The numerical excess or diminution of the pyloric appendages points in the present case to the probability that the two fish are not Salmon. The numbers 48–50 are considerably below the minimum of *S. salar*, but come within the range of the Central-European Lake Salmonoids—to wit, the four last mentioned in the table; likewise *S. trutta*.

One of the most constant characters is said by Dr. Günther to be the size and consequently relative numbers of the scales. In our specimens the horizontal series of these, 120–122, does not exclude the notion of their being Salmon; neither does it show if they are, or are not, specifically separate. The numbers, however, do not tally with the minimum or maximum of several of the species (*vide* Table A), and in this rather agree than otherwise with *S. salar*.

Of the transverse or, rather, somewhat oblique series of scales superior to the longitudinal medio-lateral line, and counted in a row from the dorsal fin to the said lateral line, one specimen (that designated No. 1, P. Z. S. 1868, p. 251) possesses nineteen, possibly more, as shall presently be explained; the other specimen (No. 2, *l. c.*) twenty-two. The latter number is given by Dr. Günther as the numerical minimum of *S. salar*; the former falls three short of it. Hence, as regards this differentiating character, No. 1 apparently

is not a Salmon. It must be borne in mind, moreover, that in my previous communication I stated that the number of scales counted in the specimen was not rigidly accurate, those given as transversely inclined to the long axis of the body being decidedly under rather than above the precise amount. I say so advisedly; for on reexamining specimen No. 1, and taking a linear row of scales slightly in advance of the point previously chosen, and therefore more in accordance with Günther's plane of obliquity, I find that twenty-one or twenty-two (?) are definable. But howsoever this may be, the penultimate column to the right of the table here given (p. 37) conclusively demonstrates that, even in limited numbers of scales, the dubious specimens in question agree less with the undernoted species of *Salmo* than with *S. salar*.

Lastly, this remark applies with still greater force to the scales counted linearly from the lateral line to the ventral fin, with the *proviso* that those of the lake fishes of mid-Europe are unrecorded.

II. *Uncertainty of the species.*—Upon this point it need only be said that, if not *Salmo salar*, it is most remarkable, and fatally telling to the denial of parentage, that the fish correspond to none of the European types, either in size, markings, or other distinguishing characteristics. Had therefore a mistake happened as to the recognition of the ova, this would have ultimately rectified itself in the development of the specific characters applicable to adult piscine form.

III. *The question of hybridity.*—As respects hybridity, which Dr. Günther suggests may be the case with those specimens reared in the Gardens, it becomes rather an important item of deliberation. On what grounds can it be assumed we have hybrid fish to deal with, granting, for the time being, no set line of demarcation proving their identity with a single specific form can be given?

1. The produce of different species may have been fertilized at the Rhine fish-hatching establishment.

2. Instances of hybrids among certain of the Salmonidæ are stated to be of no uncommon occurrence.

3. Our specimens possess resemblances to none of the well-established forms, but have appearances indicating intermediate origin.

As experiments prove, the fertilization of the ova of one piscine form with the milt of another distinct species is beyond controversy exemplified in hybrids between the Salmon and the Trout. It is needless therefore to shirk the reasonable contingency of intermixture of breed having accidentally or intentionally supervened. Against such a circumstance it can be advanced that, so far as is known, the authorities at Huningue did not with intent form a cross breed and transmit the impregnated ova of such to this country as pure *Salmo salar*. Moreover, to the practised eyes of Buckland and Bartlett, the ova were those of Salmon; and the period of hatching coincided with that of that fish rather than with that of the Great-Lake Trout, Charr, Salmon-trout, or Common Trout, received in the beginning of the same year, 1863. This fact also tends adversely to the presumption of accidental hybridity.

Dr. Günther himself professes to have been sceptical concerning hybrid Salmonoids under natural conditions, until convinced, through the Rev. Augustus Morgan, of a cross between the Sewin (*S. cambricus*) and the River-trout (*S. fario*)*.

It is said "These hybrids are so numerous in the Rhymney and other rivers of South Wales, and so variable in their characters, that the passage from one species to the other may be demonstrated in an almost unbroken series, which might induce some naturalists to regard both species as identical." They retain the migratory impulse seawards, and are sexually developed in the autumn,—when young, are like Trout—when older, Sewin. On their first ascent from the sea they are slightly smaller, but closely resemble Sewin. On their second migratory return they are darker and redder than either supposed parent. These equivocal hybrids, W. Peel, Esq., of Taliaris Park, retained for years in a freshwater pond, where they grew from 15 to 18 inches long, but remained sterile. Males preponderate.

It is not stated precisely on what evidence these fishes claim hybridity, more than that they bear resemblances to both species. Indeed, from Dr. Günther's own descriptions, the Sewin characters preponderate. If, therefore, Siebold's observations, checked by Widegren's subsequent data (viz. that some individuals of every Salmonoid species are very late in being sexually developed, or have as it were a longer temporary immaturity, and during such period differ from those normally developed), be applied to this instance of hybridism, it may on such grounds be maintained that the said hybrids are after all nothing but retarded examples of *S. cambricus*.

Taken in this light, these so-called hybrids offer coincident analogies to the retarded conditions assumed to occur in *S. salar*, and notably in those two specimens which have formed the basis of the present paper.

It seems to me also a legitimate inference that the two fishes reared in our aquarium are Salmon, inasmuch as they differ in a far greater degree from all other European species than from *S. salar*. Indeed, as is broadly admitted in the British-Museum Catalogue, p. 3, of the genus *Salmo*, "The almost infinite variations of these fishes are dependent on age, sex and sexual development, food, and the properties of the water;" hence this very same reasoning which demonstrates peculiarities in the two Salmonoids and brood in question, logically points to their immaturity, retardation, or masking of the normal adult characters of the species. If their entire growth has been prejudicially influenced by continuous retention in fresh water, so may a defect or abnormal number of scales (two transversely) and pyloric appendages (three or four) be but the concomitant effect of unnatural development.

Suppose, again, our oft-quoted Garden specimens were a cross breed between any two well-known species, freshwater or marine, there remains still a wide loophole of doubt why they have remained so very small-sized. No European species whatever, to my know-

* See B. M. Cat. of Fishes, vol. vi. p. 8.

ledge, are so stunted when full-grown. Thus it follows that either lessened dimension is a result of hybridity, or the two specimens a distinct species *per se*.

In a conversation with my colleague Mr. Bartlett concerning this same question of hybridism and the size of the offspring, I received such information, based on his long experience among animals, that I think it worthy of incorporation in the present paper. From it some hints applicable to fish may be derived, or at least borne in mind, in discussing piscine forms.

His proposition is, "That among all hybrids of vertebrated animals there is a marked increase of size." In no instance coming under his observation has the offspring been smaller than both its parents. In other words, it is always larger than the lesser-sized parent; that is, supposing inequality of dimensions between the parents to exist.

Among Mammals the following examples may be cited:—

1, Hybrids between Horse and Ass; 2, the Common Zebra and Common Ass; 3, Burchell's Zebra and the Common Ass; 4, the Wild Ass (*Equus onager*) and the Zebra; 5, the Bactrian and Common Camel; 6, the Alpaca and Llama; 7, the Yak and Zebu; 8, the Barbary and Red Deer; 9, the Rhesus and Bonnet Monkey; 10, the Black-fronted and Yellow-cheeked Lemurs (*L. nigrifrons* and *L. xanthomystax*); 11, Bennett's and the Rufous Kangaroo (*Halmaturus bennettii* and *H. ruficollis*).

Among Birds:—

12. Hybrids between the Common Canary and the following, viz. the Greenfinch, the Goldfinch, the Linnet, and the Siskin.

13. Among the Galinaceous Birds, hybrids between the Common Pheasant and the Silver Pheasant, the Gold Pheasant and the Bar-tailed Pheasant; also hybrids between the Common Pheasant and the Common Fowl, the Guinea-fowl and the Black Grouse.

14. Hybrids between the Black Cock and the Wood-grouse; in this case the offspring is termed *Tetrao medius* because of the constancy of this very peculiarity as regards size.

15. Of Struthious Birds one cross only has come under Mr. Bartlett's notice, namely a hybrid between the Great-billed and the Common Rhea. Curiously enough, this offspring was larger than either of the parents.

16. Among Waterfowl a very large number might be adduced as evidence; but the subjoined may suffice:—Hybrids between the Common Goose and the Chinese species, the Canada, the White-fronted, and the Barnacle Goose (indeed cross breeds amongst various sorts of Domestic and Wild Geese have many times been observed by him); hybrids between the Common Wild Duck, the Wigeon, the Pintail, the Teal, and the Muscovy Duck. These and other instances of Waterfowl have frequently come under his notice; and in all cases the afore-mentioned law applies.

As respects fishes, authentic observations upon hybrid progeny are meagre; but I may quote some experiments made at Stormontfield.

In November and December 1857 provision was made for hatching

in separate compartments the artificially impregnated ova of:—1, Parr and Salmon; 2, Grilse and Salmon; 3, Grilse pure; 4, Salmon pure. It was found, when the young of these different matches came to be examined early (in April 1859), that the size of each kind varied a little, Mr. Buist*, Superintendent of Fisheries, informing us that:—1st, the produce of Salmon with Salmon are 4 in. in length; 2nd, Grilse with Salmon $3\frac{1}{2}$ in.; 3rd, Grilse with Grilse $3\frac{1}{2}$ in.; 4th, Parr with Grilse 3 in.; 5th, Smolt from large pond 5 in."

Unfortunately these experiments do not apply to the instance in point, hybridity; but they show that intercrossing between the, so to speak, imperfect form though sexually developed fish and the mature individual gives rise to diminished offspring; whereas two mature specimens produce young which, at least in their earlier stage, are of larger growth. The result, though seemingly disparaging to what Mr. Bartlett has stated of mammals and birds, is in reality not against it; for his remarks have reference to the adult hybrid and not to the juvenile condition.

Addenda.

Whilst I have freely used data tendered by friends, it is right for me frankly to state they do not concur in the sum total of my deductions; for these therefore I am alone responsible. It gives me pleasure, though, to make known some of their views, as evincing both concord and disagreement with those held by myself.

The following is a report of a statement by Mr. Buckland, which I immediately wrote out and obtained full liberty to publish.

"Salmon-ova are generally deposited from the middle of December until the middle of January.

"Young fish of the first year may be observed in the spawning-streams about May. In July and August they are as big as Minnows. The mothers risk their own lives for the safety of their progeny; they make every effort to get to places where food is abundant for their young. Some of those hatched, say, at Christmas put on the Smolt coat in the following spring; but the great majority of these young fish do not go to the sea till the spring of what may be considered their second year. They have then attained the dimensions of a Sprat.

"If a shoal of Smolts be examined whilst they are passing down, some will be seen to be only of the size of Minnows, whereas others will be quite as large as Sprats; the little ones are those of the first year's brood, the big ones of the second year's series.

"Some Smolts remain to the third year; but these differ very much from their brethren, their residence in the fresh water giving them quite a Trout-like appearance. These latter are found as long as 5 or 6 inches, and are called 'Heppers' in the west of England. They are beautiful fish, with well-developed Parr-markings, and much more common in the west of England than in the north of England. It is possible that these 'Heppers' remain in the upper

* A writer in the 'Illustrated London News,' April 19, 1862.

waters because no suitable floods occur for them to come down; and hence they are obliged to stay an extra year in fresh water. It may be that these fancy Parr-markings are a provision of nature for concealment when in the young state.

"There is good evidence of a second migration of Smolts in the month of September. This is quite a new fact; but Mr. Buckland is fully inclined to believe it, because he is of opinion that as yet *no universal law can be defined as respects migration of Salmon.*

"Nature seems to anticipate the deaths of a large number during their migratory ascent and descent, so that a Salmon river, like Jacob's ladder, has fish most months of the year, some going up and others going down. If nature sent all the Smolts of the first year into the sea in the spring of the second year, some accident might happen and all be destroyed.

"It happens instead that the crop of full-grown Salmon becomes due about the fifth year from those reared in the first year; thus a certain number are always coming into condition.

"As respects the return of Grilse, these are equivalent or *pro rata* to the descent of the Smolts. It is not at all a likely circumstance, from what is known of the return numbers, that the large quantities which as Smolts arrive in the sea in the spring of the second year will ascend in July and August of the same year. But there can be no question that they sometimes do so, if Sir William Jardine's remarks on Salmonidæ be consulted.

"Furthermore, it is a curious circumstance that in 1867 no Grilse came back from the sea throughout the entire United Kingdom. Concerning this fact a consultation was held at Mr. Buckland's rooms, and among those present were several experienced Scottish netters. The opinions expressed were very diverse, and may be arranged numerically thus:—

"1. Some held that the fish had never been hatched.

"2. Some concluded they never went down.

"3. Others believed the fish were all destroyed in the sea.

"4. Others conceived that the deficiency of return Grilse was caused by an unusual natural phenomenon unknown to man, yet wide-spread.

"5. Several parties expressed themselves that the fish would return early in the summer and autumn of 1869; and, strange to say, they did come back in enormous numbers at the time specified. Indeed the Irish fisheries in 1869 have far surpassed most of the previous seasons, and particularly in the vast preponderance of Grilse compared with Salmon. Some of the Grilse were large; but the majority were not much, if any, larger than their ordinary dimensions.

"In estimating the value of a Salmon-fishery, the calculation ought to be based upon an epoch of five years, or a *quinquennial* period. A generation of men is counted by thirty years; so in like manner a generation of Salmon ought to be estimated at five years. Some say, however, nine years; but the law of probability is rather in favour of five years.

"The term arrest of development of the Smolt, Mr. Buckland thinks, is not a scientific term. Nature has ordained that the fish should not grow more than a certain size in fresh water; that is to say, there is a maximum of growth and size in the Smolt. The transmutation of the Smolt into a Salmon takes place in the sea. Here, for the first time, we find that wonderful provision (which Mr. Buckland lays great stress on), the storing of fat on the pyloric appendages. Smolts have no fat on the pyloric appendages; but Grilse have. Non-migratory Salmonidæ have no pyloric fat; but Sea-trout possess it.

"The reason why Smolts will never become Salmon in fresh water has some relation to this development into the superior from the inferior stage of organization. This stage is not necessary for life. Salmon will live a long time in fresh water in the inferior condition, yet never pass over the line of demarcation between the two stages, unless conditions for the perfection of the secondary form be present. This is shown in the fact that nature actually orders a new coat for the creature when it passes from the one condition of things to the other.

"If the migratory instinct is impeded by human intervention, the dress assumed at such times disappears, and the fish (by a happy provision of Providence) continues to wear its Parr-coat, which, as the fish gets bigger, becomes increased in intensity. The 'Heppers' already spoken of exemplify this.

"The arrest of development is a term, therefore, which can only strictly be applied to Salmon in the sea, inasmuch as the arrest is simply the first natural stage of the progressive series of growths. Such stages of Salmon-growth have a parallel in the changes of insect-form: thus egg =ovum, caterpillar =parr, chrysalis =Smolt, and the butterfly =Salmon, may be said to be the analogous stages whereby insect and Salmon pass from the imperfect to the perfect condition."

Among what I have classed as addenda comes, as undernoted, a Table of dimensions (B). In the first notice (P. Z. S. 1868, p. 253) I was only able to give in detail those of specimen No. 1; but No. 2 has died since, and thus permitted its linear measurements to be taken. I have placed alongside these five other specimens, four of which are nearly similar in length, and the other that of a full-grown fish. These are specimens described individually by Dr. Günther in his Catalogue, and have been chosen by me to illustrate the proportional sizes and relations of the parts of the body to each other in an immature Salmon, a Sewin, a quasi-hybrid, a *S. nigripinnis*, and a fully developed *S. salar*. As the fractions used in the Catalogue are chiefly given in fourths, eighths, and sixteenths of an inch, I have converted these into decimals, enabling comparison between my two specimens and them more readily to be drawn therefrom.

Columns I. and II. relate to the Society's specimens, described in the previous paper.

Column III. relates to a young male Salmon (Parr), from the

Kulder (a rocky mountain-stream joining the river Tyne, in Northumberland), with the testicles fully developed.

Column IV. to a Sewin, or Bull Trout (*S. cambricus*) from the Rhymney. A male in the Smolt state, before going down the sea.

Column V. gives the admeasurements of one of the so-called hybrids between the Sewin (*S. cambricus*) and the River-trout (*S. fario*). "A young female from the Towey, caught in the month of August."

Column VI. gives those of a male specimen of the *S. nigripinnis*, with testicles well developed. "From Llyn Gadr, caught in the month of August."

Column VII. gives those of a perfect-conditioned male Salmon from the river Tweed.

Table B.

	I. Zool. Soc. spec. No. 1, Proc. 1868.	II. Zool. Soc. spec. No. 2, Proc. 1868.	III. Salmon-parr, B. M. Cat. p. 21.	IV. Sewin, Smolt, B. M. Cat. p. 45.	V. Hybrid? B. M. Cat. p. 57.	VI. *S. nigripinnis*, B. M. Cat. p. 99.	VII. *S. salar*, ad., B. M. Cat. p. 16.
	in.	in.	in.	in.	in.	in.	in.
Total length	6·5	7·6	6·5	6·87	7·50	8·00	46·0
Greatest depth of body	...	1·2	1·43	1·37	1·50	1·62	11·50
Length of the head	1·4	1·2	1·37	1·43	1·56	1·75	10·50
Least depth of tail	...	0·6	0·56	0·56	0·62	0·75	3·33
Distance from end of snout to eye	0·3	0·45	0·37	0·37	0·37	0·37	4·50
Length of maxillary bone	0·6	0·75	0·43	0·56	0·62	0·75	3·75
Distance between eye and præopercular angle	...	0·5	0·37	0·50	0·50	0·62	3·33
Greatest width of operculum	...	0·4	0·37	0·37	0·37	0·37	2·12
Greatest depth of operculum	...	0·75	0·43	0·50	0·50	0·56	3·0
Distance between occiput and origin of dorsal fin	...	1·75	1·62	1·87	1·75	1·87	14·0
Distance between end of dorsal and root of caudal fin	...	2·40	2·06	2·31	2·5	2·87	15·0
Length, base of dorsal	0·9	0·85	0·75	0·75	0·75	0·87	4·66
Greatest height of dorsal	1·2	...	0·87	0·81	1·00	1·12	4·50
Length of pectoral	1·2	1·3	1·25	1·00	1·25	1·37	5·50
Distance between roots of pectoral and ventral	1·6	1·8	1·62	1·87	2·00	2·00	12·5
Length of ventral fin	...	0·9	0·87	0·75	0·87	1·12	4·66
Distance between root of ventral and origin of anal	1·2	1·15	1·0	1·00	1·37	1·37	10·5
Length of the anal	0·8	0·8	0·56	0·43	0·56	0·62	3·33
Length of longest caudal ray	...	1·1	1·06	0·87	1·12	1·25	6·00
Length of middle caudal ray	...	0·55	0·43	0·56	0·56	0·62	...

Between the Society's two specimens there is a close agreement, the head of No. 1, however, being proportionally and absolutely the longest. The Parr (III.) corresponds to both, the main disagree-

ment being in the less depth of the operculum, and smaller size of the dorsal and anal fins.

The Sewin, excepting in a smaller ventral fin, is almost intermediate between the three foregoing. The hybrid (?) varies in proportional dimensions little from the preceding; the head may be considered a trifle longer than in them, as also the distance betwixt the dorsal and caudal fins, betwixt the pectoral and ventral fins, and betwixt the ventral and anal. Considering that the specimen of *S. nigripinnis* is a shade larger fish, its admeasurements wonderfully harmonize with the five already mentioned.

What, therefore, appears to be elicited is that, *pari passu*, the fishes No. 1 and No. 2, fully four and five years old respectively, are almost identical in the relative proportions of their bodies with what may be assumed much younger Parr, Sewin Smolt, hybrid Sewin, and the so-called *S. nigripinnis*.

Taking column VII. into consideration, and contrasting it with III., the relative growths of the several parts of the Salmon's body to each other (from the Parr to the adult condition) are proved to be unequal in ratio. The total lengthening of the body, in the instances cited, is $=7$ times. The depth of the body increases $\times 8$. The head elongates $\times 7{\cdot}6$. The least depth of the tail has an increment $= \times 5{\cdot}9$. The distance from the end of the snout to the eye enlarges $\times 12{\cdot}1$ times, or in the male the anterior segment of the face is proportionally excessively developed, a fact not at variance with the proportion between adult male and female Salmon. The maxillary bone grows in length $\times 8{\cdot}7$. The distance between the eye and the opercular angle increases nine times from the Parr to the adult stage as a Salmon. The operculum widens $\times 5{\cdot}7$, and its depth becomes $= \times 7$. Betwixt the occiput and the dorsal fin the intervening space lengthens by $\times 8{\cdot}7$, and that betwixt the dorsal and caudal fin $7{\cdot}2$ times. The elongation basally of the dorsal fin is $= \times 6{\cdot}2$, and its height $= \times 5{\cdot}1$. The pectoral fin lengthens $\times 4{\cdot}4$; but the increase of distance between the roots of the pectoral and ventral fins is $= \times 7{\cdot}7$. The elongation of the ventral fin proceeds to $\times 5{\cdot}3$ times, whereas the distance between the root of the ventral and the origin of the anal fin becomes $= \times 10{\cdot}5$. The anal fin grows $5{\cdot}9$ times as long, the longest caudal ray $\times 5{\cdot}6$.

The above data are of course only approximate, as from the comparison of only two specimens it would be unfair to draw conclusive deductions; but, taken for what they are worth, computation gives the following general results:—

1. The average measurements of the development of the body, head, occiput to dorsal fin, dorsal to caudal, and pectoral to ventral fins are as $7{\cdot}44$ to 1.

The amount of divergence between the ventral and anal fins, $10{\cdot}5$ to 1, is much greater than the foregoing maximum and minimum, an anomaly possibly dependent on sex.

2. The ratio of increase of the maxillary and the eye to that of the operculum averages $8{\cdot}85$ to 1.

3. The average elongation of the fins is as $5{\cdot}26$ to 1.

4. The depth of the body and root of tail differ as regards augmentation, the former being as 8 to 1, the latter as 5·9 to 1.

5. Between the width and depth of the operculum, respectively 5·7 and 7 to 1, the horizontal to vertical increase is inversely to what obtains in the body.

Availing one's self of these considerations, and comparing specimens I. and II. with III. (Table B), it will be seen, more especially in the older fish, II., that the maxillary bone and distance from snout to eye are proportionally larger than in the Parr. The same may be said as regards growth of the operculum, more particularly its depth. The distance between the ventral and anal fins is also sensibly greater. Thus those parts which in the adult, *cæteris paribus*, show the greatest relative accretion are, curiously enough, in the Salmonoids reared in fresh water, the parts which have most increment. From this it follows that whilst a general arrest of development, retardation of growth, or whatsoever the term used, has occurred from the altered physical circumstances, still the proportional magnitude of the parts has kept pace with that of a normally developed adult Salmon favoured by visits to the sea.

General Conclusions.

The main fact at issue—Can *Salmo salar* live for series of years in fresh water without access to the sea?—if not settled beyond cavil, has, I venture to think, in this and the preceding paper, been tolerably well substantiated. At least the evidence of many observers has been given; so that it remains for those who discountenance the view to show the fallacy of the data, and prove on evidence as reliable that the contrary is the true state of the case. This does not interfere with the necessity of further experiments being tried. For my own part, I am quite willing to bow acknowledgment to whichever side the truth lies on—though, after an impartial consideration, I cannot escape or reason away the strong presumptive allegations positively confirming the opinion. To me they are reasonable, because based on what, in homely parlance, are deemed everyday occurrences. The principle in the life-history of the Salmon which seems at variance with its customary habits is in reality not so; what takes place as a general rule is here but temporarily departed from. In the physical constitution of animals, the limits assigned to the well-being of the individual are not so rigidly exact as a mathematical problem; hence, to judge rightly, we must know all, or be prepared to confute abnormal phases of existence. In the present instance the choice of credence lies between testimony harmonious with laws regulating the primary growth of Salmon, and suppositions framed on circumstances we have but an imperfect knowledge of, unless it be satisfactorily shown that the statements of such a truthful observer as Yarrell, or the instance recorded by Anderson, are fictitious or egregiously false.

Those who deny that some Salmon, few or many, can permanently accommodate themselves to a freshwater residence for a comparatively